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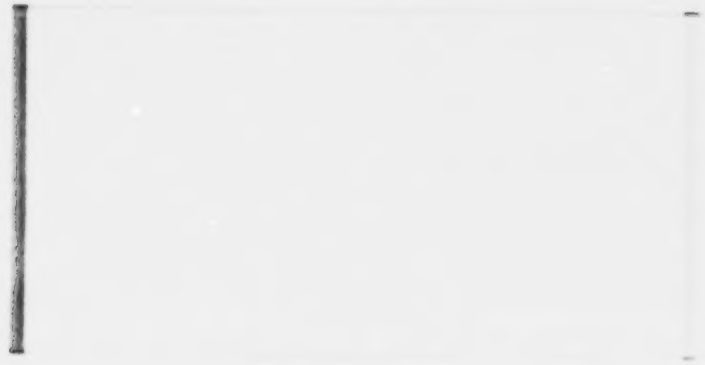

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# AUTOMATION OF WEIRS AT SIR ADAM BECK'S PUMPED STORAGE RESERVOIR

Report No 85-162-K

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## ABSTRACT

Two weirs measuring water flow in the vicinity of Sir Adam Beck's Pumped Storage Reservoir were automated to enable operators to monitor each weir remotely. In the event of high water levels, the system provides both audio and visual warnings to personnel in the operator's room. This report provides the setup details, technical specifications and performance information relating to the monitoring system.



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AUTOMATION OF WEIRS AT SIR ADAM BECK'S
PUMPED STORAGE RESERVOIR

## 1.0 INTRODUCTION

At the request of Mr. R.T. Judek of Civil Works, an automated monitoring system was designed and installed in two weirs within the vicinity of Sir Adam Beck's Pump Storage Reservoir by the Rock Sciences Section (Civil Research). The system was set up to enable plant operators to continuously monitor water levels in both weirs from the control room. A warning system would alert plant personnel in the event of high water levels which could be indicative of reservoir embankment failure.

This report provides a breakdown of the monitoring system along with detailed equipment specifications, which have been included in Appendix A. Information relating to the operation of the system and performance test results have also been included in this report.

## 2.0 LOCATION

The location of Sir Adam Beck's Generating Stations and the pumped storage reservoir are shown in Figure 1. Figure 2 shows the location of the two weirs as found on the eastern portion of the pumped storage reservoir along with the Pump Generating Station (PGS). Weir 1 and weir 2 are respectively located 0.60 km and 1.70 km from the PGS.

## 3.0 WEIR MONITORING SYSTEM

Each of the two weir monitoring systems consists of the following major components: 1) pressure transducer with transmitter, 2) 4 to 20 ma transmission cable, 3) indicator panel with digital display and warning signals, and 4) voltage regulator (Figure 3).

### 3.1 Pressure Transducer with Transmitter

The transducer measures pressure and transmits the data to the indicator panel via the transmission cable. The transmitter's supply voltage is also received over the transmission cable from the operator's room located in the pump generating station. The body of the gauge is titanium which has been electron beam welded. A polyurethane sheathed cable is moulded to the body to complete a high integrity waterproof assembly. The accuracy of the unit is 0.1% of full scale output and has an overpressure rating of four times. Its operating pressure range is from zero to five psi within a -20°C to +60°C temperature range.

The pressure transducer is placed with its sensing diaphragm near the bottom of the approach channel and measures the water height before the water spills over the V-notch of the weir (Figure 3). Further details on water level measurement readings is provided in a subsequent section. The transducer has been securely fastened to a steel support to keep the instrument fixed and reading in a vertical position (Figure 4). A protective steel mesh screen has been placed around each transducer in the weir to keep foreign materials such as branches from contacting the gauge (Figures 5 and 6). To avoid potential transducer damage in the winter, heaters and heat lamps have been installed in each weir housing to keep the water from freezing (Figures 4 and 5).

### 3.2 Transmission Cable

The transmission cable is composed of 22 gauge, 4 to 20 ma standard twisted pair with shielding and covered with a durable waterproofed polyurethane sheathing. Its function is to provide DC voltage to the pressure transducer from the indicator/controller in the operator's room and transmit pressure readings from the pressure transducer back to the indicator/controller. Weir 1 has a transmission cable length of approximately 0.60 km while weir 2 has a length of about 1.70 km.

Both cables have been buried except for a minor length near the power generating station where the cables have been hung on hydro poles. The major reason for burying the cables was to protect them against possible damage such as that resulting from vandalism.

### 3.3 Indicator/Controller

Each of the two weirs has an indicator/controller box which is mounted in a nineteen-inch rack panel and placed in the controller's room to monitor the readings provided by the pressure transducers (Figure 7). The indicator/controller features a digital readout with Hi-Lo limit detection and both visual and audio warning systems. A red light and buzzer come on when water levels reach a predetermined high water level, while an amber light and buzzer come on when the transmission circuit is incomplete (ie severed cable). The indicator/controller on the left side on the rack panel monitors weir 1, while the one on the right side monitors weir 2.

The digital readout has been setup to read percentages from zero to one hundred, where zero percent is equal to the bottom of the V-notch and indicates no flow and one hundred percent is equal to the top of the V-notch and indicates the maximum flow within the notch. Although readings up to 250 percent are possible and do accurately measure the water height in the approach channel, it should be emphasized that water flow measurements in excess of one-hundred percent are no longer contained in the V-notch and must therefore be dealt with in a different manner. This situation is to be addressed by the Civil Works Department of Ontario Hydro.

The red light and alarm is set to go off at the one-hundred percent level in each weir. This suggests that high flow rates have been achieved as a result of a rainstorm, meltwaters, damming up of the weir or an embankment failure. The operator can turn the alarm off with a key which overrides the buzzer (Figure 7). The red light, however, stays on until the water level drops below the one-hundred percent level. When levels reach the one-hundred percent level, the operator should follow the instructions as set out by the Civil Works Department.

### 3.4 Voltage Regulator

It was noted that the power in the pump generating station varied many times during the course of a day when pumps were turned on or off. It was assumed that this type of voltage fluctuation would falsely set off the alarm signals in the indicator/controller boxes. As a result, a voltage regulator (Figures 8 and 9) was placed in the AC power supply leading to each indicator/controller box. The regulator provides instantaneous voltage regulation and ultra isolation from both transverse and common mode noise for any type of load. Input line voltage variations as great as 15 percent are instantaneously regulated to a maximum output deviation of 7 percent. The regulator is a simple, rugged device without moving parts or manual adjustments and requires no routine servicing or maintenance.

### 3.5 Performance Test and Interpretation

The digital percentage reading relates directly to the height of water above the bottom of the V-notch. In weir 1, one-hundred percent equals 8 inches (20.32 cm), while in weir 2, one-hundred percent equals 9 inches (22.86 cm). Figures 10 and 11 show the relationships between percentage readings and water height for weirs 1 and 2, respectively. To convert, 1% = 0.08 inches (0.20 cm) in weir 1 and 1% = 0.09 inches (0.23 cm) in weir 2. For calibration purposes, Figures 12 and 13 show the relationships between milliamps and water height for weirs 1 and 2, respectively.

Subsequent to setting up the monitoring system, a performance test was conducted for a period of approximately one month (February 20 to March 26, 1985). Readings were taken every four hours for both weirs and recorded on a data logger. The results of the performance test are shown in Figures 14 and 15. For convenience of graphing, the Julian Day Calendar was used to represent the time scale on the x-axis. Figure 16 shows the Julian Day Calendar for ease of reference. Figures 14 and 15 both show a horizontal

dashed line which indicates the one-hundred percent water level at the top of the V-notch. This indicates that the alarm system would have sounded twice for weir 1 (February 22 and 23) and twice for weir 2 (February 23 and March 8). In both these cases, rainstorms and snow melting were responsible for setting off the alarms. The unusual peak shown in Figure 14 for weir 1 on March 4 has been attributed to temporary damming within the weir. The data collected for both weirs is provided in Table 1. Figure 17 shows the behaviour of water levels in both weirs with time. It is quite apparent that both weirs are responding in a similar fashion to various increases or decreases in water levels surrounding the PGS reservoir. This indicates that both monitoring systems are performing well.

### 3.6 Recommendations

To maximize the lifetime of the monitoring system and maintain its overall reliability, both the equipment and weirs must be maintained. The following recommendations are suggested:

(1) weirs should be checked regularly and cleaned of branches, leaves, sedimentation, etc (debris could affect proper operation of system);

(2) heaters and heat lamps should be operating at all times during the winter to ensure that freezing in the weir does not occur (freezing could damage the transducer);

(3) no alterations or adjustments should be made to the monitoring system without first contacting the Civil Research Department;

(4) the monitoring systems for both weirs should be checked and calibrated yearly by the Civil Research Department;

(5) the Civil Research Department should be contacted when the amber light on the indicator panel comes on (this suggests a malfunction in the monitoring system).

## 4.0 CONCLUSIONS

The Rock Sciences Section (Civil Research) has designed and installed two weir monitoring systems within the vicinity of Sir Adam Beck's Pump Storage Reservoir. Each system continuously monitors the height of water in the weir and alerts the operators in the control room when high water levels are attained. The components and operation of the monitoring system have been described. In addition, results of a performance test have been presented and discussed.

## 5.0 ACKNOWLEDGEMENTS

We wish to thank the staff at PGS for their excellent cooperation and assistance during the installation of the monitoring system.

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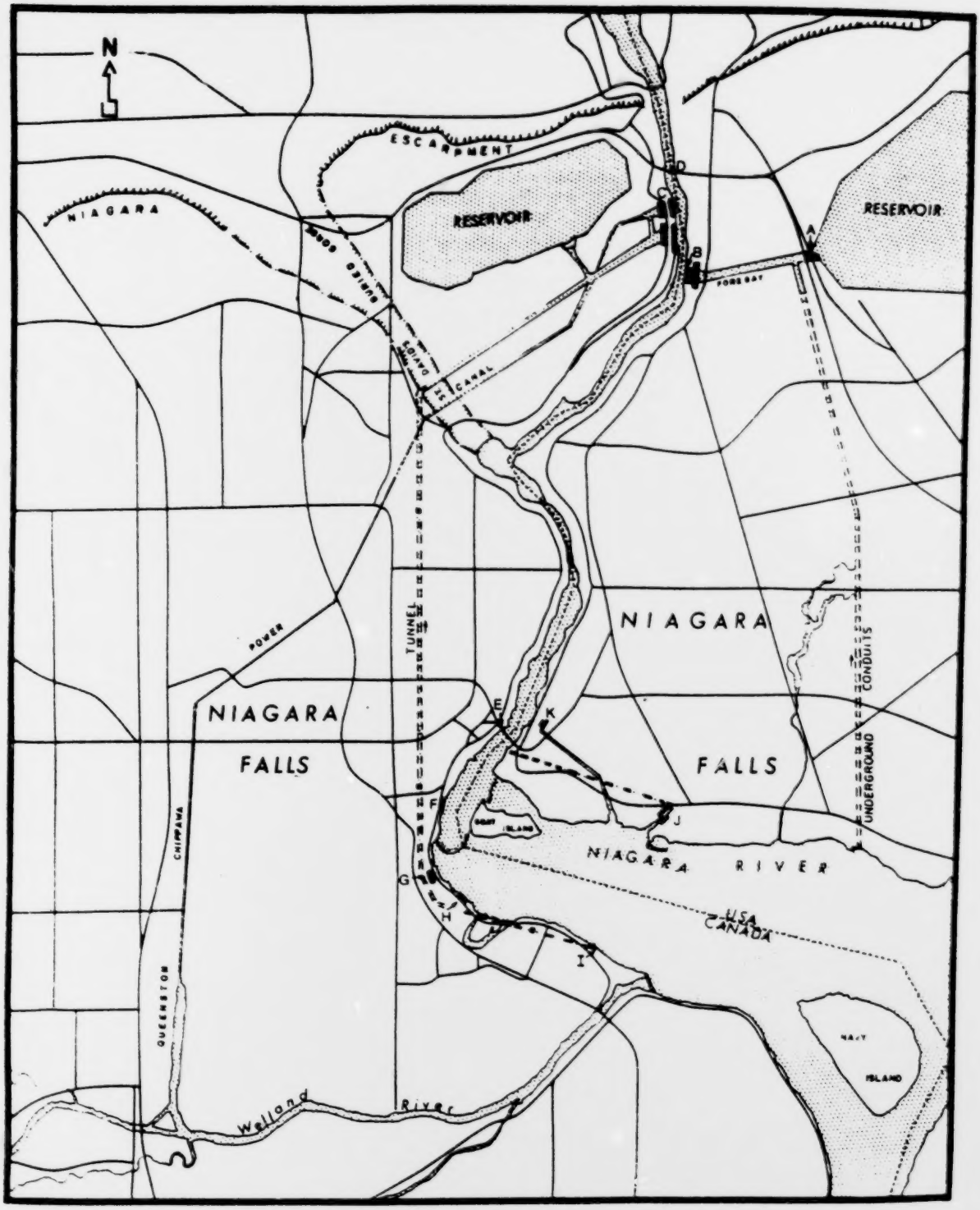


Figure 1
Location of Sir Adam Beck's Storage Reservoir



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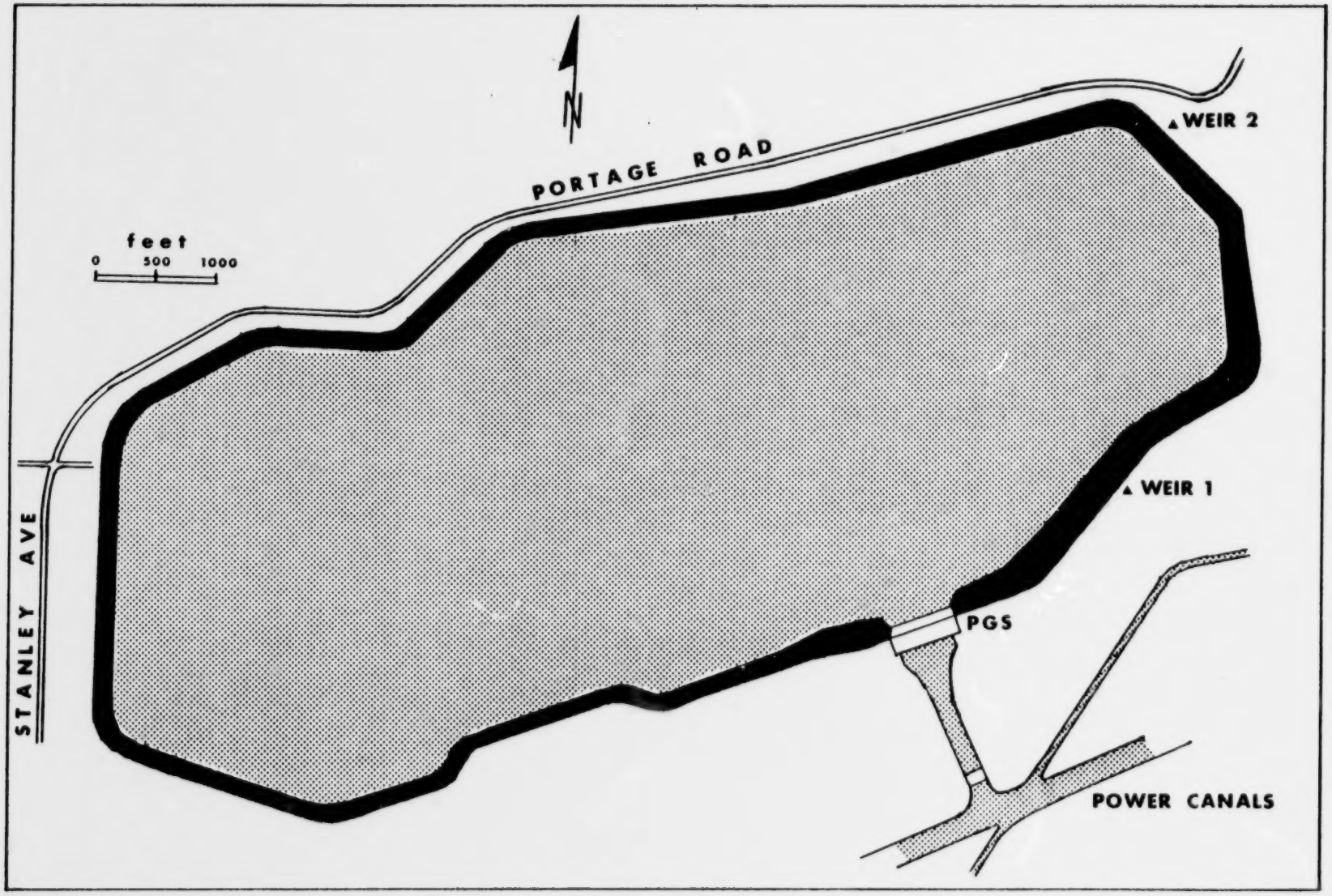



Figure 2
Plan View Showing Storage Reservoir, Pump Generating Station and Weirs

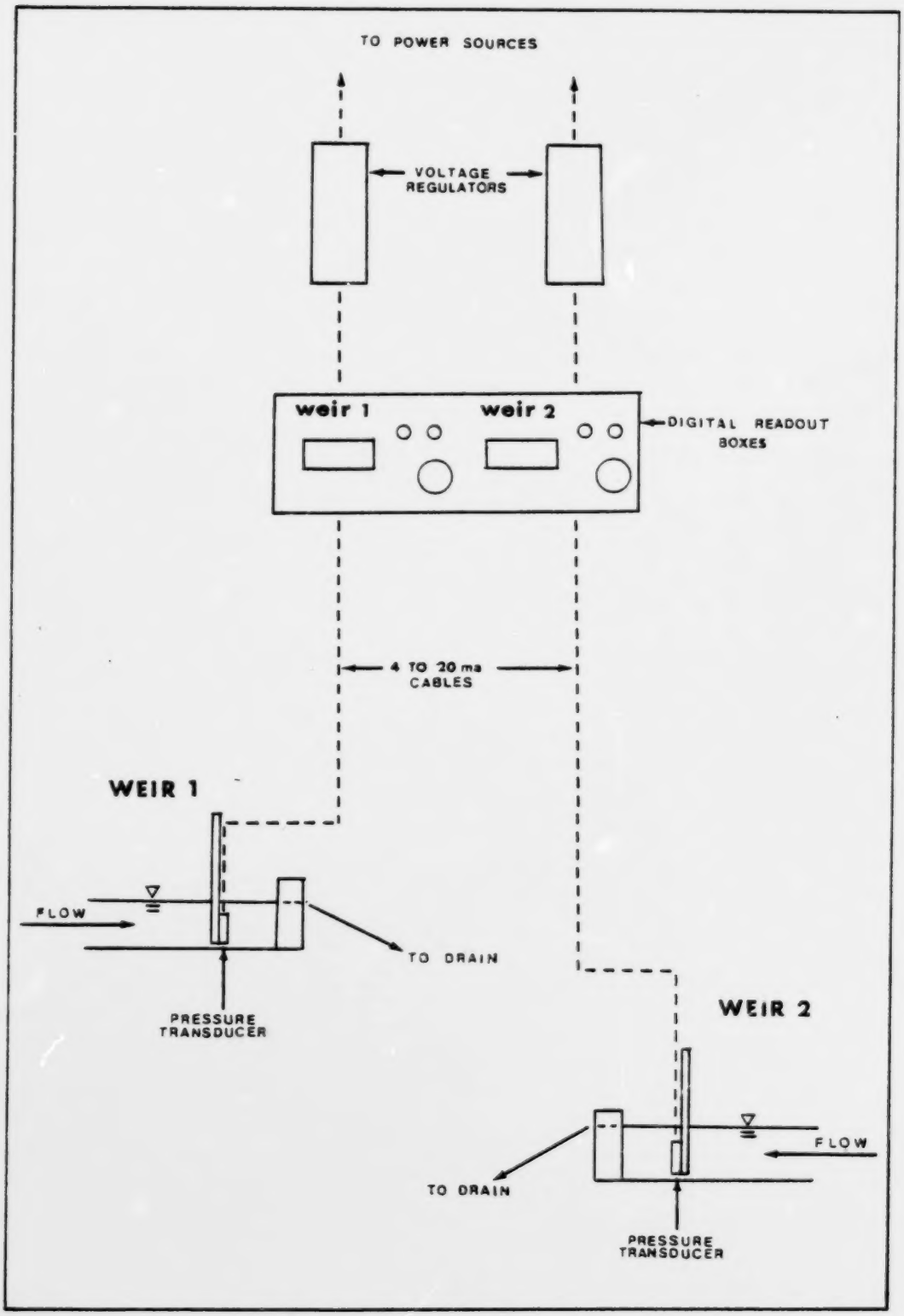



Figure 3
Schematic of Weir Monitoring System

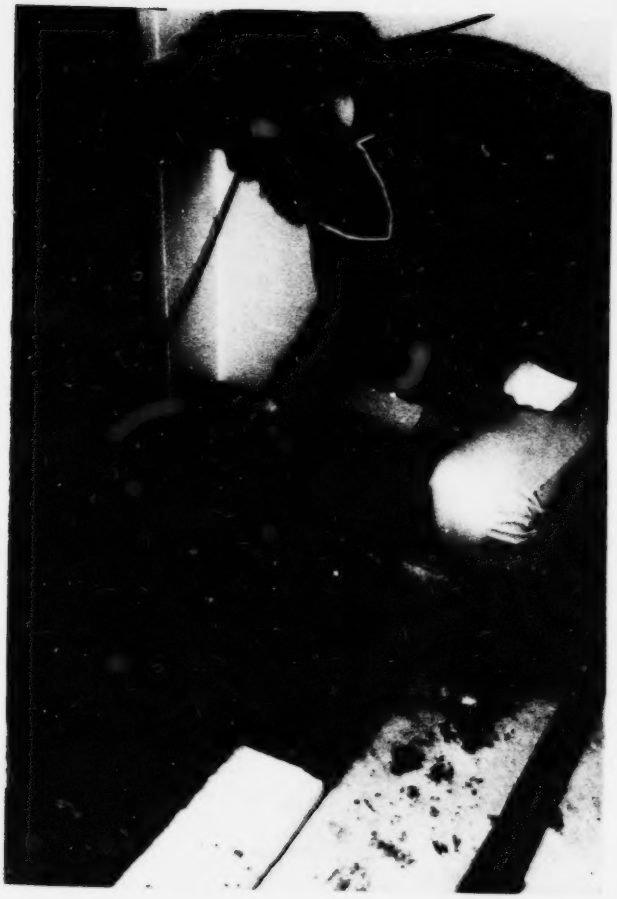


Figure 4
Weir Housing Showing Transducer Support, Heat Lamp and Weir Notch

Figure 5
Plan View Showing V-Notch (Bottom Centre),
Pressure Transducer and Heat Lamp (Upper Right)

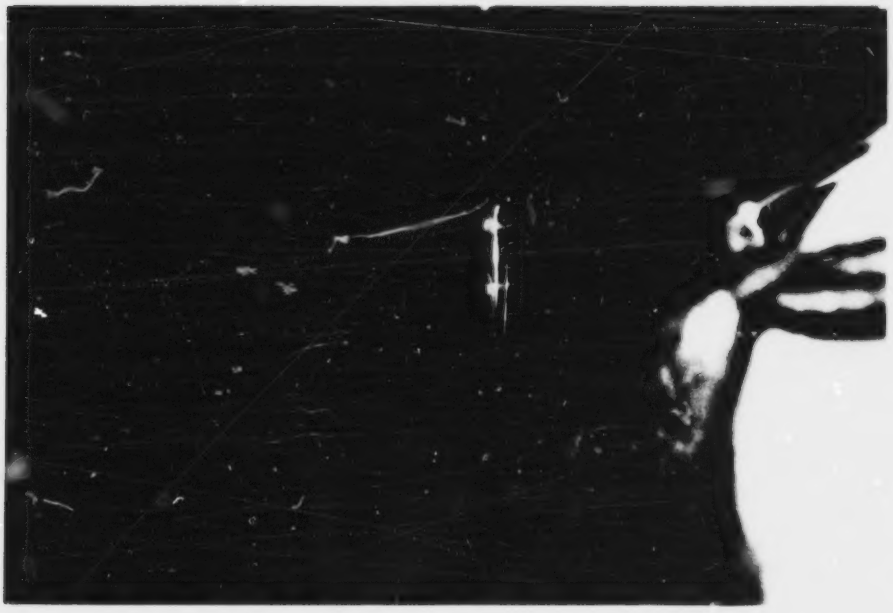


Figure 6
Pressure Transducer Fixed to Vertical Support Inside Protective Cage

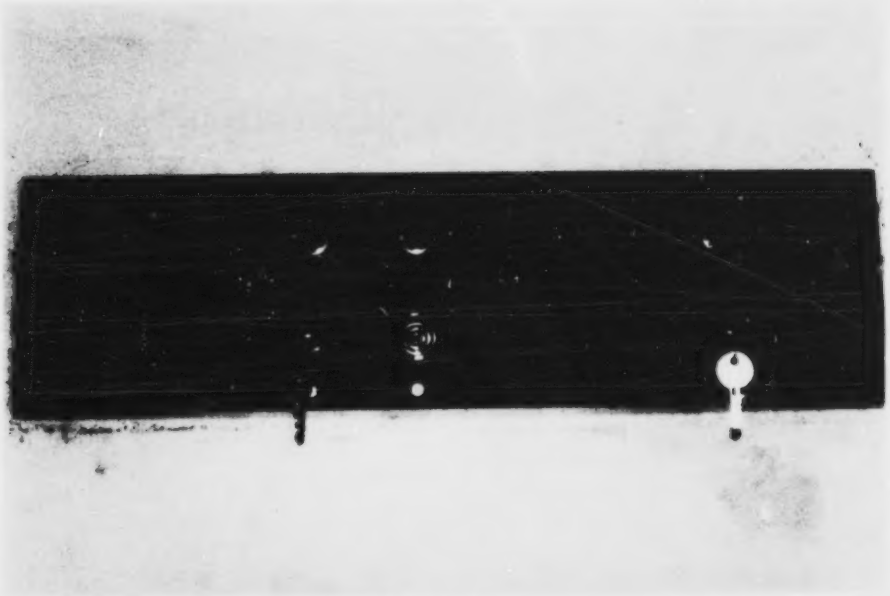


Figure 7
Indicator/Controller for Each Weir with Digital Readout,
High-Low Warning Lights and Override Key

Figure 8
Reverse Side of Indicator/Controller Panel and
Voltage Regulators for Each Weir

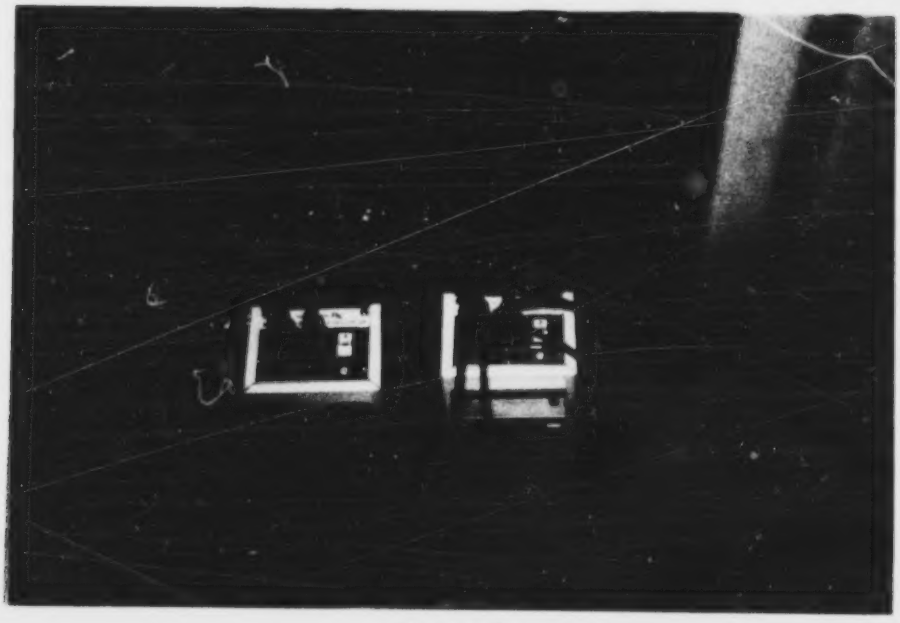


Figure 9
Close-up of Voltage Regulators for Each Weir

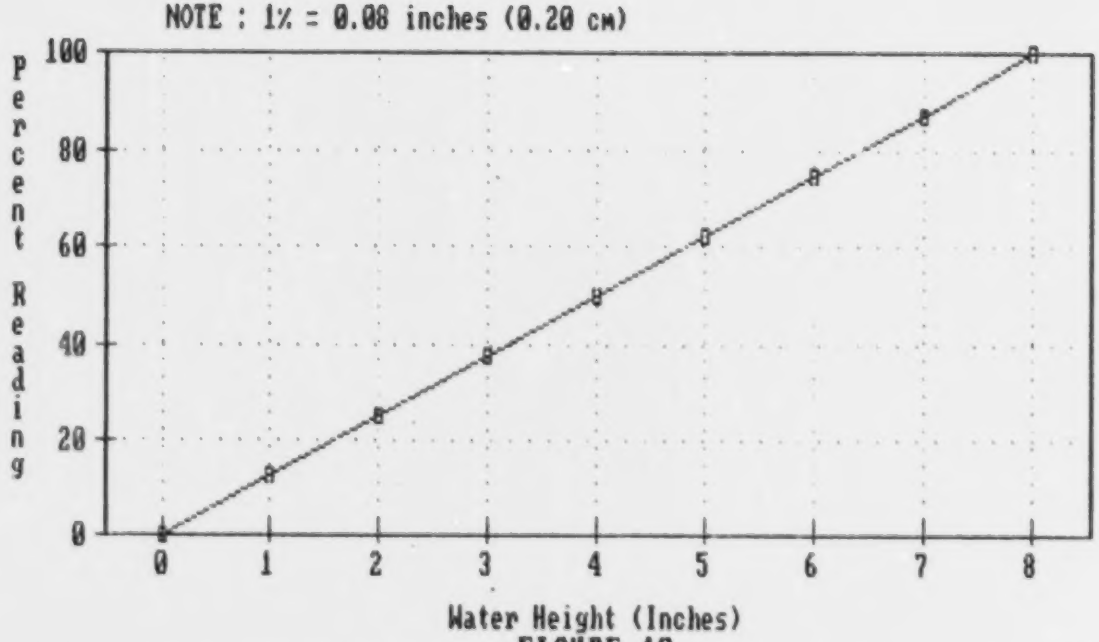



FIGURE 10
PERCENTAGE VERSES WATER HEIGHT IN WEIR 1

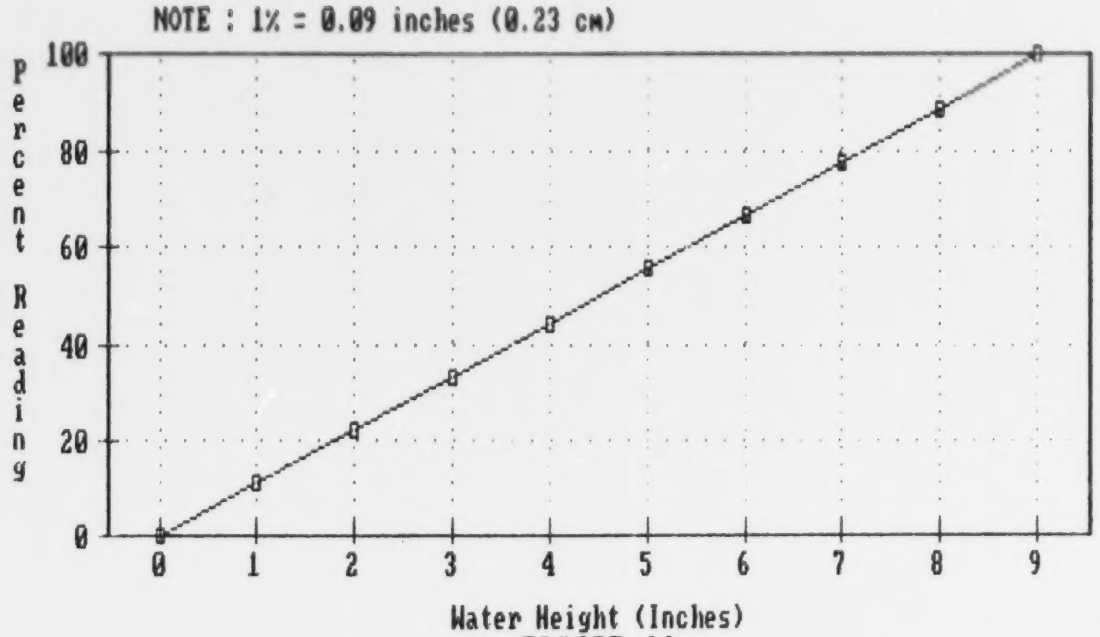



**FIGURE 11**
**PERCENTAGE VERSES WATER HEIGHT IN WEIR 2**

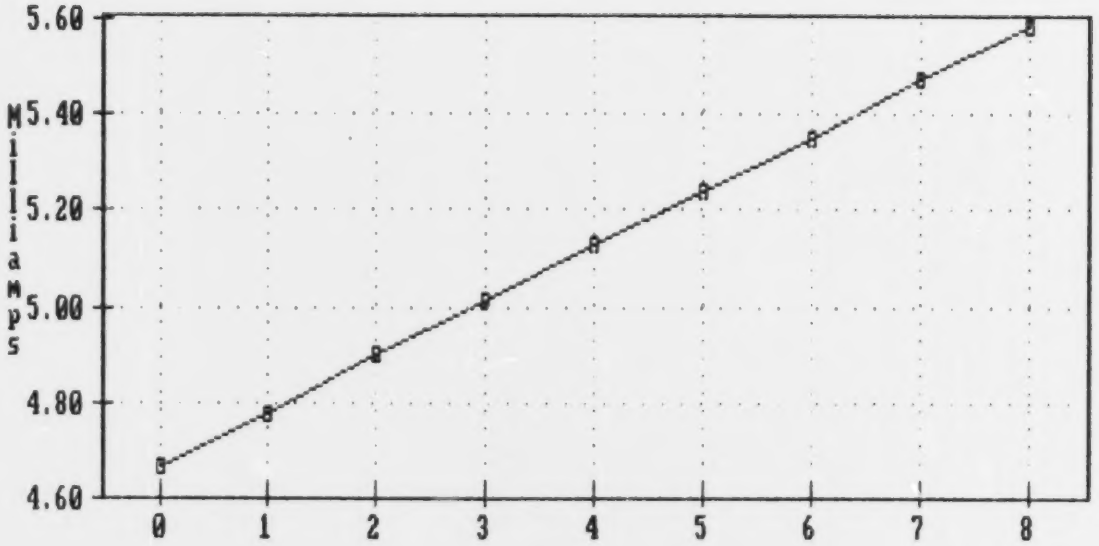



FIGURE 12
MILLIAMPS VERSES WATER HEIGHT IN WEIR 1

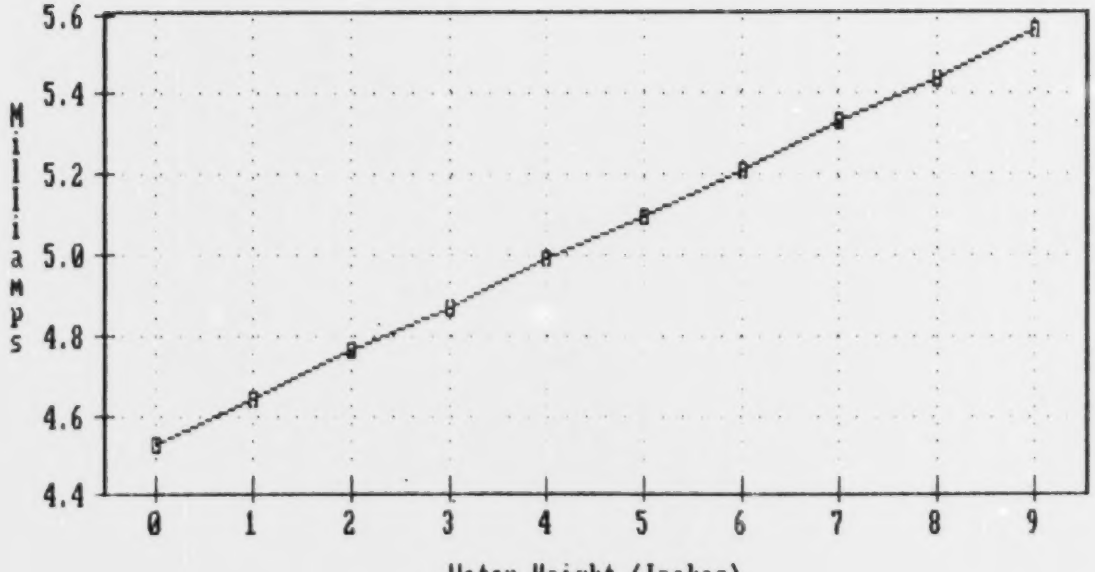



**FIGURE 13**
**MILLIAMPS VERSES WATER HEIGHT IN WEIR 2**

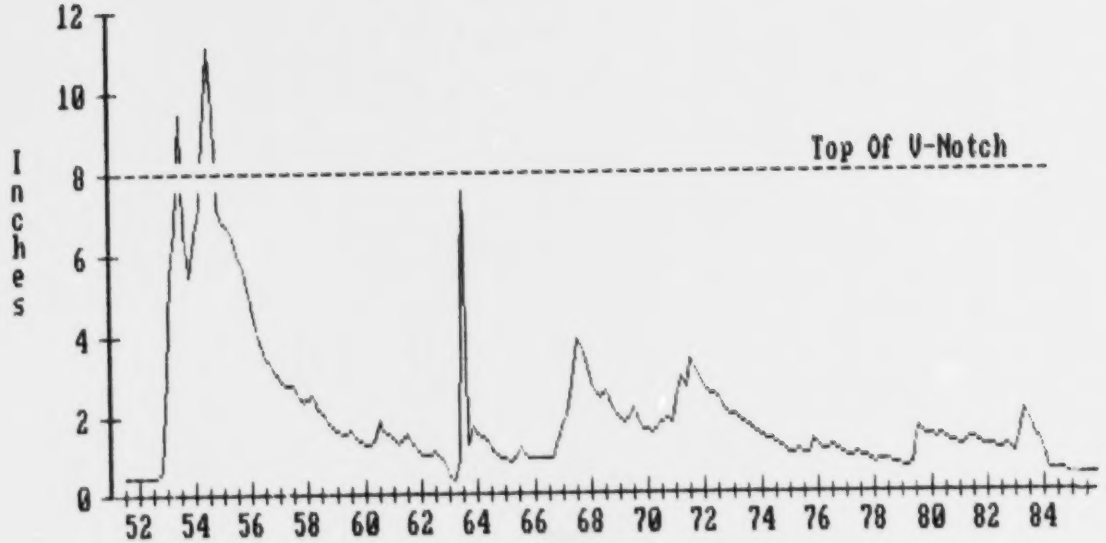



**FIGURE 14**
**PGS WEIR 1 - WATER LEVEL VERSES TIME**

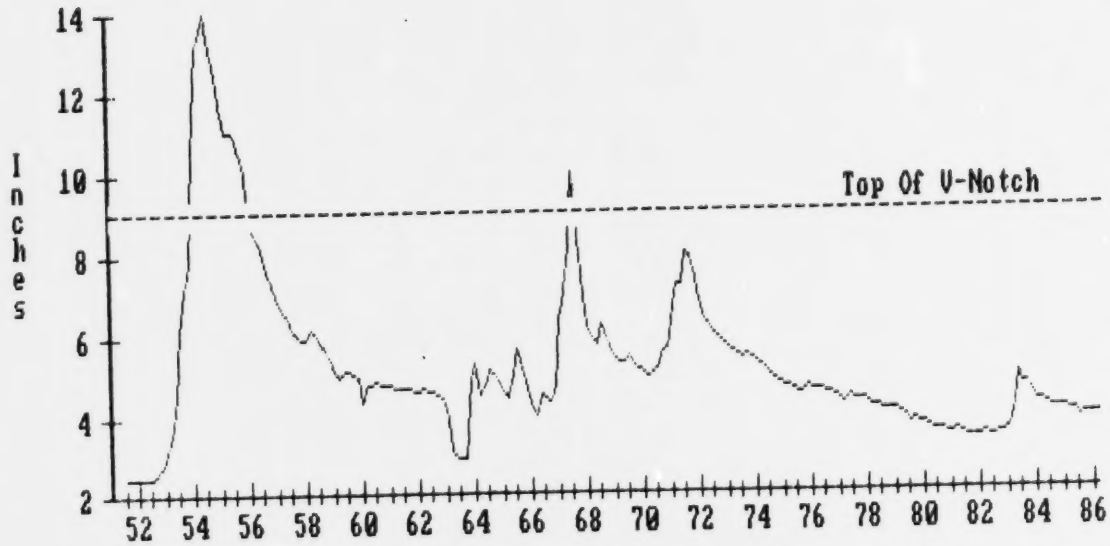



**FIGURE 15**
**PGS WEIR 2 - WATER LEVEL VERSES TIME**

# JULIAN DAY CALENDAR

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JAN | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| FEB | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | | |
| MAR | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| APR | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | |
| MAY | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 |
| JUN | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | |
| JULY | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 |
| AUG | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 |
| SEP | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | |
| OCT | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 |
| NOV | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 333 | 334 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | |
| DEC | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 |

Figure 16
Julian Day Calendar

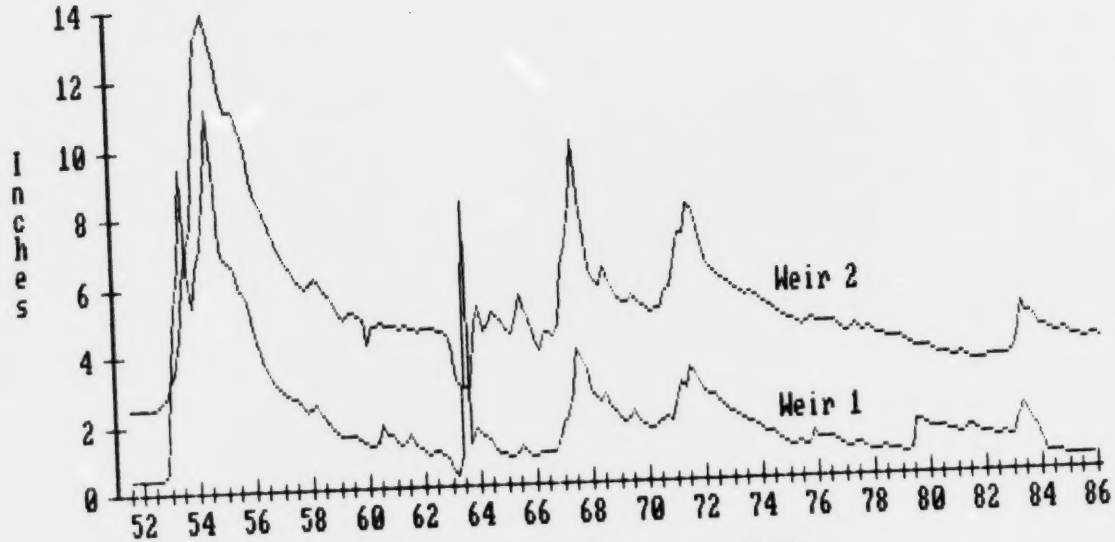



**FIGURE 17**
**PGS WEIRS 1 AND 2 - WATER LEVEL VERSES TIME**

TABLE 1

Equipment Check - Water Levels with Time in Weirs 1 and 2

| Date (1985) | Julian Day Calendar | Time (hrs) | Water Height (inches) Weir 1 | Weir 2 |
|---|---|---|---|---|
| Feb 20 | 51 | 1600 | 0.50 | 2.50 |
| 20 | 51 | 2000 | 0.50 | 2.50 |
| 20 | 51 | 2400 | 0.50 | 2.50 |
| Feb 21 | 52 | 400 | 0.50 | 2.50 |
| 21 | 52 | 800 | 0.50 | 2.50 |
| 21 | 52 | 1200 | 0.50 | 2.50 |
| 21 | 52 | 1600 | 0.50 | 2.50 |
| 21 | 52 | 2000 | 0.50 | 2.70 |
| 21 | 52 | 2400 | 0.70 | 2.85 |
| Feb 22 | 53 | 400 | 3.00 | 3.20 |
| 22 | 53 | 800 | 5.50 | 3.50 |
| 22 | 53 | 1200 | 6.70 | 4.50 |
| 22 | 53 | 1600 | 9.50 | 6.20 |
| 22 | 53 | 2000 | 6.50 | 7.10 |
| 22 | 53 | 2400 | 5.50 | 7.85 |
| Feb 23 | 54 | 400 | 6.50 | 10.50 |
| 23 | 54 | 800 | 7.20 | 13.25 |
| 23 | 54 | 1200 | 9.00 | 13.60 |
| 23 | 54 | 1600 | 11.20 | 14.00 |
| 23 | 54 | 2000 | 9.50 | 13.20 |
| 23 | 54 | 2400 | 7.10 | 12.50 |
| Feb 24 | 55 | 400 | 6.75 | 11.75 |
| 24 | 55 | 800 | 6.70 | 11.10 |
| 24 | 55 | 1200 | 6.50 | 11.10 |
| 24 | 55 | 1600 | 6.00 | 11.00 |
| 24 | 55 | 2000 | 5.75 | 10.50 |
| 24 | 55 | 2400 | 5.40 | 10.00 |
| Feb 25 | 56 | 400 | 4.75 | 9.00 |
| 25 | 56 | 800 | 4.20 | 8.50 |
| 25 | 56 | 1200 | 3.75 | 8.25 |
| 25 | 56 | 1600 | 3.50 | 7.90 |
| 25 | 56 | 2000 | 3.25 | 7.50 |
| 25 | 56 | 2400 | 3.00 | 7.10 |
| Feb 26 | 57 | 400 | 2.90 | 6.90 |
| 26 | 57 | 800 | 2.80 | 6.60 |
| 26 | 57 | 1200 | 2.75 | 6.40 |
| 26 | 57 | 1600 | 2.75 | 6.20 |
| 26 | 57 | 2000 | 2.50 | 6.00 |
| 26 | 57 | 2400 | 2.35 | 5.89 |
| Feb 27 | 58 | 400 | 2.40 | 5.93 |
| 27 | 58 | 800 | 2.46 | 6.20 |
| 27 | 58 | 1200 | 2.16 | 6.96 |
| 27 | 58 | 1600 | 2.08 | 5.82 |
| 27 | 58 | 2000 | 1.91 | 5.63 |
| 27 | 58 | 2400 | 1.68 | 5.33 |

TABLE 1 (cont'd)

| Date (1985) | Julian Day Calendar | Time (hrs) | Water Height (inches) Weir 1 | Weir 2 |
|---|---|---|---|---|
| Feb 28 | 59 | 400 | 1.60 | 5.14 |
| 28 | 59 | 800 | 1.55 | 4.91 |
| 28 | 59 | 1200 | 1.55 | 5.15 |
| 28 | 59 | 1600 | 1.58 | 5.14 |
| 28 | 59 | 2000 | 1.47 | 5.05 |
| 28 | 59 | 2400 | 1.36 | 4.91 |
| Mar 1 | 60 | 400 | 1.28 | 4.29 |
| 1 | 60 | 800 | 1.24 | 4.80 |
| 1 | 60 | 1200 | 1.40 | 4.75 |
| 1 | 60 | 1600 | 1.90 | 4.84 |
| 1 | 60 | 2000 | 1.58 | 4.77 |
| 1 | 60 | 2400 | 1.55 | 4.76 |
| Mar 2 | 61 | 400 | 1.41 | 4.73 |
| 2 | 61 | 800 | 1.24 | 4.65 |
| 2 | 61 | 1200 | 1.36 | 4.71 |
| 2 | 61 | 1600 | 1.56 | 4.68 |
| 2 | 61 | 2000 | 1.29 | 4.65 |
| 2 | 61 | 2400 | 1.14 | 4.59 |
| Mar 3 | 62 | 400 | 1.04 | 4.60 |
| 3 | 62 | 800 | 0.98 | 4.65 |
| 3 | 62 | 1200 | 1.04 | 4.62 |
| 3 | 62 | 1600 | 1.12 | 4.57 |
| 3 | 62 | 2000 | 0.94 | 4.53 |
| 3 | 62 | 2400 | 0.85 | 4.40 |
| Mar 4 | 63 | 400 | 0.52 | 4.12 |
| 4 | 63 | 800 | 0.40 | 3.11 |
| 4 | 63 | 1200 | 0.92 | 2.94 |
| 4 | 63 | 1600 | 8.31 | 2.92 |
| 4 | 63 | 2000 | 1.25 | 2.92 |
| 4 | 63 | 2400 | 1.69 | 4.82 |
| Mar 5 | 64 | 400 | 1.55 | 5.26 |
| 5 | 64 | 800 | 1.48 | 4.51 |
| 5 | 64 | 1200 | 1.33 | 4.80 |
| 5 | 64 | 1600 | 1.16 | 5.10 |
| 5 | 64 | 2000 | 1.00 | 5.00 |
| 5 | 64 | 2400 | 0.93 | 4.78 |
| Mar 6 | 65 | 400 | 0.89 | 4.55 |
| 6 | 65 | 800 | 0.87 | 4.45 |
| 6 | 65 | 1200 | 0.95 | 5.00 |
| 6 | 65 | 1600 | 1.16 | 5.60 |
| 6 | 65 | 2000 | 0.98 | 5.08 |
| 6 | 65 | 2400 | 0.91 | 4.65 |
| Mar 7 | 66 | 400 | 0.91 | 4.20 |
| 7 | 66 | 800 | 0.94 | 3.97 |
| 7 | 66 | 1200 | 0.94 | 4.48 |
| 7 | 66 | 1600 | 0.94 | 4.44 |
| 7 | 66 | 2000 | 0.94 | 4.36 |
| 7 | 66 | 2400 | 1.35 | 4.65 |

TABLE 1 (cont'd)

| Date (1985) | Julian Day Calendar | Time (hrs) | Water Height (inches) Weir 1 | Weir 2 |
|---|---|---|---|---|
| Mar 8 | 67 | 400 | 1.78 | 6.36 |
| 8 | 67 | 800 | 1.99 | 7.03 |
| 8 | 67 | 1200 | 2.74 | 8.14 |
| 8 | 67 | 1600 | 3.92 | 10.00 |
| 8 | 67 | 2000 | 3.62 | 8.32 |
| 8 | 67 | 2400 | 3.30 | 6.98 |
| Mar 9 | 68 | 400 | 2.75 | 6.16 |
| 9 | 68 | 800 | 2.49 | 5.86 |
| 9 | 68 | 1200 | 2.42 | 5.75 |
| 9 | 68 | 1600 | 2.58 | 6.27 |
| 9 | 68 | 2000 | 2.24 | 5.91 |
| 9 | 68 | 2400 | 2.05 | 5.59 |
| Mar 10 | 69 | 400 | 1.90 | 5.37 |
| 10 | 69 | 800 | 1.80 | 5.25 |
| 10 | 69 | 1200 | 1.90 | 5.25 |
| 10 | 69 | 1600 | 2.11 | 5.43 |
| 10 | 69 | 2000 | 1.83 | 5.22 |
| 10 | 69 | 2400 | 1.64 | 5.11 |
| Mar 11 | 70 | 400 | 1.58 | 5.01 |
| 11 | 70 | 800 | 1.56 | 4.96 |
| 11 | 70 | 1200 | 1.68 | 5.02 |
| 11 | 70 | 1600 | 1.80 | 5.10 |
| 11 | 70 | 2000 | 1.91 | 5.58 |
| 11 | 70 | 2400 | 1.81 | 5.66 |
| Mar 12 | 71 | 400 | 2.32 | 6.32 |
| 12 | 71 | 800 | 2.91 | 7.19 |
| 12 | 71 | 1200 | 2.66 | 7.18 |
| 12 | 71 | 1600 | 3.37 | 8.01 |
| 12 | 71 | 2000 | 3.14 | 7.90 |
| 12 | 71 | 2400 | 2.85 | 7.27 |
| Mar 13 | 72 | 400 | 2.65 | 6.77 |
| 13 | 72 | 800 | 2.50 | 6.32 |
| 13 | 72 | 1200 | 2.47 | 6.12 |
| 13 | 72 | 1600 | 2.31 | 5.96 |
| 13 | 72 | 2000 | 2.15 | 5.89 |
| 13 | 72 | 2400 | 2.01 | 5.76 |
| Mar 14 | 73 | 400 | 1.95 | 5.66 |
| 14 | 73 | 800 | 1.88 | 5.55 |
| 14 | 73 | 1200 | 1.81 | 5.44 |
| 14 | 73 | 1600 | 1.73 | 5.35 |
| 14 | 73 | 2000 | 1.66 | 5.49 |
| 14 | 73 | 2400 | 1.56 | 5.35 |
| Mar 15 | 74 | 400 | 1.45 | 5.27 |
| 15 | 74 | 800 | 1.37 | 5.16 |
| 15 | 74 | 1200 | 1.37 | 5.08 |
| 15 | 74 | 1600 | 1.29 | 4.93 |
| 15 | 74 | 2000 | 1.14 | 4.85 |
| 15 | 74 | 2400 | 1.06 | 4.72 |

TABLE 1 (cont'd)

| Date (1985) | Julian Day Calendar | Time (hrs) | Water Height (inches) Weir 1 | Weir 2 |
|---|---|---|---|---|
| Mar 16 | 75 | 400 | 1.02 | 4.66 |
| 16 | 75 | 800 | 1.00 | 4.65 |
| 16 | 75 | 1200 | 1.06 | 4.59 |
| 16 | 75 | 1600 | 1.02 | 4.48 |
| 16 | 75 | 2000 | 0.99 | 4.54 |
| 16 | 75 | 2400 | 1.36 | 4.68 |
| Mar 17 | 76 | 400 | 1.16 | 4.58 |
| 17 | 76 | 800 | 1.13 | 4.57 |
| 17 | 76 | 1200 | 1.13 | 4.56 |
| 17 | 76 | 1600 | 1.17 | 4.54 |
| 17 | 76 | 2000 | 1.11 | 4.54 |
| 17 | 76 | 2400 | 0.99 | 4.39 |
| Mar 18 | 77 | 400 | 0.88 | 4.29 |
| 18 | 77 | 800 | 0.89 | 4.24 |
| 18 | 77 | 1200 | 1.00 | 4.45 |
| 18 | 77 | 1600 | 0.96 | 4.34 |
| 18 | 77 | 2000 | 0.88 | 4.28 |
| 18 | 77 | 2400 | 0.79 | 4.30 |
| Mar 19 | 78 | 400 | 0.77 | 4.23 |
| 19 | 78 | 800 | 0.81 | 4.18 |
| 19 | 78 | 1200 | 0.83 | 4.11 |
| 19 | 78 | 1600 | 0.80 | 4.08 |
| 19 | 78 | 2000 | 0.77 | 4.07 |
| 19 | 78 | 2400 | 0.72 | 4.04 |
| Mar 20 | 79 | 400 | 0.67 | 4.03 |
| 20 | 79 | 800 | 0.67 | 3.97 |
| 20 | 79 | 1200 | 0.72 | 3.86 |
| 20 | 79 | 1600 | 1.62 | 3.74 |
| 20 | 79 | 2000 | 1.55 | 3.77 |
| 20 | 79 | 2400 | 1.48 | 3.72 |
| Mar 21 | 80 | 400 | 1.41 | 3.68 |
| 21 | 80 | 800 | 1.40 | 3.64 |
| 21 | 80 | 1200 | 1.42 | 3.57 |
| 21 | 80 | 1600 | 1.39 | 3.51 |
| 21 | 80 | 2000 | 1.31 | 3.50 |
| 21 | 80 | 2400 | 1.26 | 3.47 |
| Mar 22 | 81 | 400 | 1.22 | 3.46 |
| 22 | 81 | 800 | 1.22 | 3.49 |
| 22 | 81 | 1200 | 1.36 | 3.43 |
| 22 | 81 | 1600 | 1.37 | 3.32 |
| 22 | 81 | 2000 | 1.28 | 3.33 |
| 22 | 81 | 2400 | 1.21 | 3.34 |
| Mar 23 | 82 | 400 | 1.20 | 3.37 |
| 23 | 82 | 800 | 1.18 | 3.44 |
| 23 | 82 | 1200 | 1.09 | 3.40 |
| 23 | 82 | 1600 | 1.07 | 3.40 |
| 23 | 82 | 2000 | 1.15 | 3.47 |
| 23 | 82 | 2400 | 1.08 | 3.46 |

TABLE 1 (cont'd)

| Date (1985) | Julian Day Calendar | Time (hrs) | Water Height (inches) Weir 1 | Weir 2 |
|---|---|---|---|---|
| Mar 24 | 83 | 400 | 1.04 | 3.50 |
| 24 | 83 | 800 | 1.63 | 3.90 |
| 24 | 83 | 1200 | 2.03 | 4.93 |
| 24 | 83 | 1600 | 1.82 | 4.70 |
| 24 | 83 | 2000 | 1.48 | 4.63 |
| 24 | 83 | 2400 | 1.26 | 4.41 |
| Mar 25 | 84 | 400 | 0.98 | 4.27 |
| 25 | 84 | 800 | 0.57 | 4.24 |
| 25 | 84 | 1200 | 0.59 | 4.15 |
| 25 | 84 | 1000 | 0.61 | 4.03 |
| 25 | 84 | 2000 | 0.55 | 4.03 |
| 25 | 84 | 2400 | 0.50 | 4.09 |
| Mar 26 | 85 | 400 | 0.46 | 4.04 |
| 26 | 85 | 800 | 0.49 | 3.48 |
| 26 | 85 | 1200 | 0.50 | 3.94 |
| 26 | 85 | 1600 | 0.51 | 3.83 |
| 26 | 85 | 2000 | 0.46 | 3.87 |
| 26 | 85 | 2400 | 0.44 | 3.92 |

APPENDIX A

# Druck

## SMALL BORE
## DEPTH TRANSMITTER
Type PTX 160/D

**Excellent linearity and hysteresis**

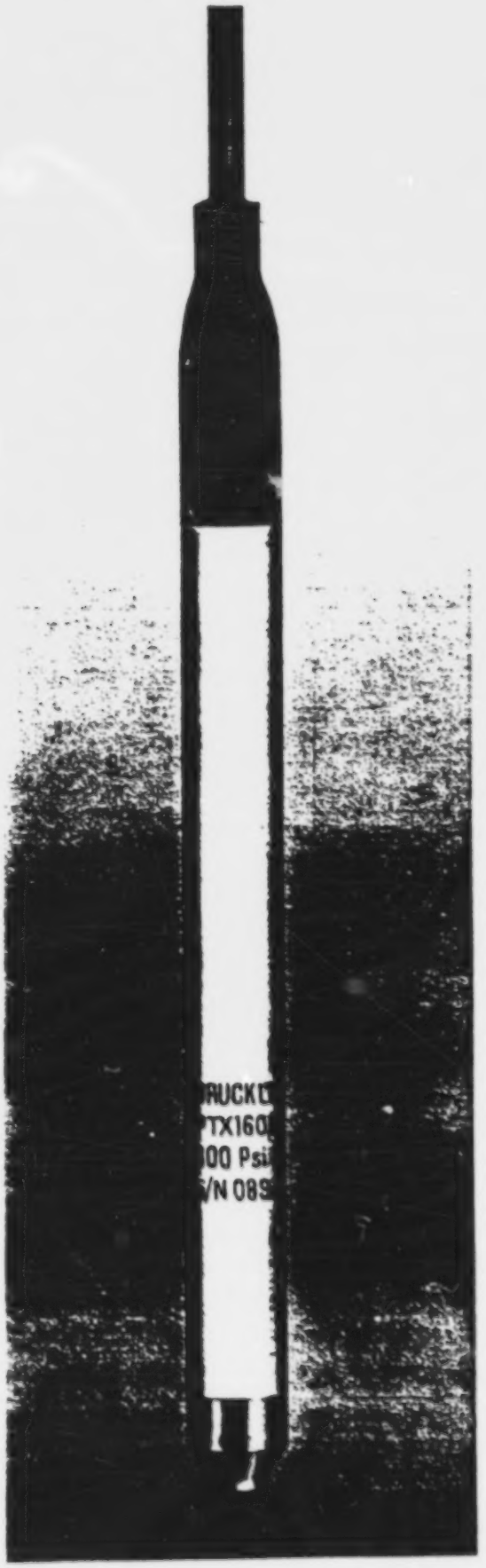
**Encapsulated electronics**

**High overload capability**

**17.5mm diameter**

**Good thermal stability**

**Two wire, 4-20mA**




**The PTX 160/D transmitter has been specifically designed where a small diameter (17.5mm) is necessary for certain bore hole applications, although it can be used in reservoirs, the sea and many other depth measurement applications. The titanium body is electron beam welded and a polyurethane sheathed cable is moulded to the body to complete a high integrity waterproof assembly.**

**The cable is tough, and complete with an integral vent tube and Kevlar strain cord.**

**The standard accuracy is 0.1% F.S. (0.06% F.S. is available) and the new electronic circuit gives very good thermal stability.**

Operating pressure ranges

70mbar, 175mbar, 350mbar, 700mbar, 1, 1.5, 2, 3.5, 5, 7, 10, 15, 20, 35, 60, 70 and 135 bar gauge.

*Other pressure units can be specified, e.g. $mH_2O$.*

*Intermediate pressure ranges are available.*

Overpressure

The rated pressure can be exceeded by the following multiples causing negligible calibration change:-

10 x for 70 and 175mbar ranges
6 x for 350mbar range
4 x for 700mbar range and above.

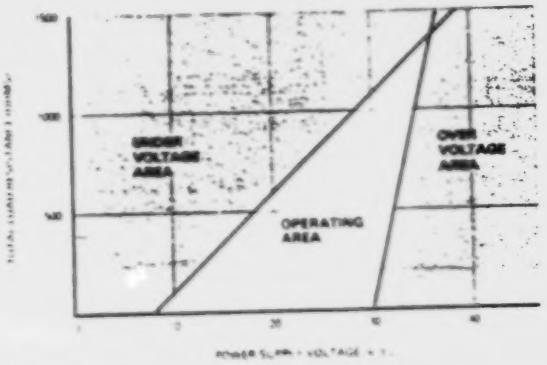
Pressure media

Fluids compatible with quartz and titanium.

Transduction principle

Integrated silicon strain gauge bridge.

**Transmitter supply voltage**
9-30V d.c.
This voltage must appear across the transmitter terminals and the positive supply must be earthed.




*For other supply voltages please refer to manufacturer*

Supply sensitivity
0.003% F.S.O./Volt and excellent 50Hz and 100Hz supply rejection.

Output current
4mA at zero pressure
20mA at full range pressure.

Resolution
Infinite

Combined non-linearity and hysteresis
±0.1% B.S.L. for 70mbar to 60 bar ranges
±0.2% B.S.L. for 70 to 135 bar ranges
*±0.06% B.S.L. available for ranges to 20 bar on request.*
*Please refer to manufacturer.*

Zero offset
±0.5% F.S.O., set @ 20°C

Sensitivity setting
±0.5% of reading, set @ 20°C

Operating temperature range
−20° to +60°C

Temperature effects
±0.3% total error band −2° to +30°C
70mbar range ±0.5% total error band −2° to +30°C.
*For special applications it is possible to give improved temperature compensation over a wider temperature range.*

Mechanical shock
1000g for 1ms in each of three mutually perpendicular axes will not affect calibration.

Dimensions
17.5mm diameter × 220mm length

Weight
113 gms. nominal.

Electrical connection
1 metre integral vented cable supplied which incorporates a Kevlar strain relieving core.
*Longer lengths available on request.*
2 Core shielded cable

| | |
|---|---|
| Red | Supply positive |
| Blue | Supply negative |
| Screen | N/C to transmitter body |

Pressure connection
Illustrated front end delrin cone fitted as standard. This incorporates a hydraulic damper to protect the device from high pressure pulses caused by underwater impact.

Pressure connections (optional)
G ¼ B
¼" N.P.T } Flat end
G ¼ B 60° Internal cone
7/16" U.N.F. as MS. 33656-4
M12 x 1.5 Ermeto
M14 x 1.5mm 6 DIN
*Others available on request.*

Options available
Pressure transducer PDCR 10/D (see separate data sheet).
Pressure connections (see above)

Ordering information
Please state the following:-
(1) Type number
(2) Pressure range
(3) Temperature range
(4) Cable length
(5) Pressure media
*For non-standard requirements please specify in detail.*
*Continuing development sometimes necessitates specification changes without notice.*

**Druck Limited**
Fir Tree Lane, Groby,
Leicestershire, LE6 0FH, England.
Telephone: Leicester (0533) 878551
Telex: 341743

Agent

ARIES INSTRUMENTS LTD.
P.O. Box 662, PICKERING, ONTARIO L1V 3T3 · TELEPHONE (416) 839-7611

ARIES INSTRUMENTS MANUAL

## ARIES INSTRUMENTS DUAL 3363 SYSTEM

### GENERAL

This system consists of two identical channels monitoring 4 to 20 mA signal sources, displaying the signals and comparing each with adjustable set points. A Daytronics Indicator for each channel provides the numeric display and over/under set points.

Pilot lamps show over/under conditions and an audible alarm signals operation of any set point.

Key operated switches allow the audible alarms to be silenced.

Two identical power supply and relay P.C.B.'s supply power for the tranducers (signal sources) and for the relays, lamps and audible alarms.

A separate P.C.B. carries coarse zero adjust networks to supplement the final zero controls on the indicator front panels.

INSTALLATION

The unit should be mounted in a 19" rack and requires four utility power sockets, 115V 60 Hz. These outlets should be connected to an electrically clean source, i.e. not on a line also supplying machinery, SCR controllers etc.

The transducers should be connected as shown in the accompanying drawings,

| | | |
|---|---|---|
| Channel 1 | I out | TERM.5 |
| Channel 1 | I in | TERM.7 |
| Channel 1 | Cable Shield | TERM.8 |
| Channel 2 | I out | TERM.4 |
| Channel 2 | I in | TERM.2 |
| Channel 2 | Cable Shield | TERM.1 |

A precision resistor is connected for Channel 2 between Terminals 2 & 3, the indicator input terminals, and for Channel 1 between Terminals 6 & 7, to give current to voltage conversion.

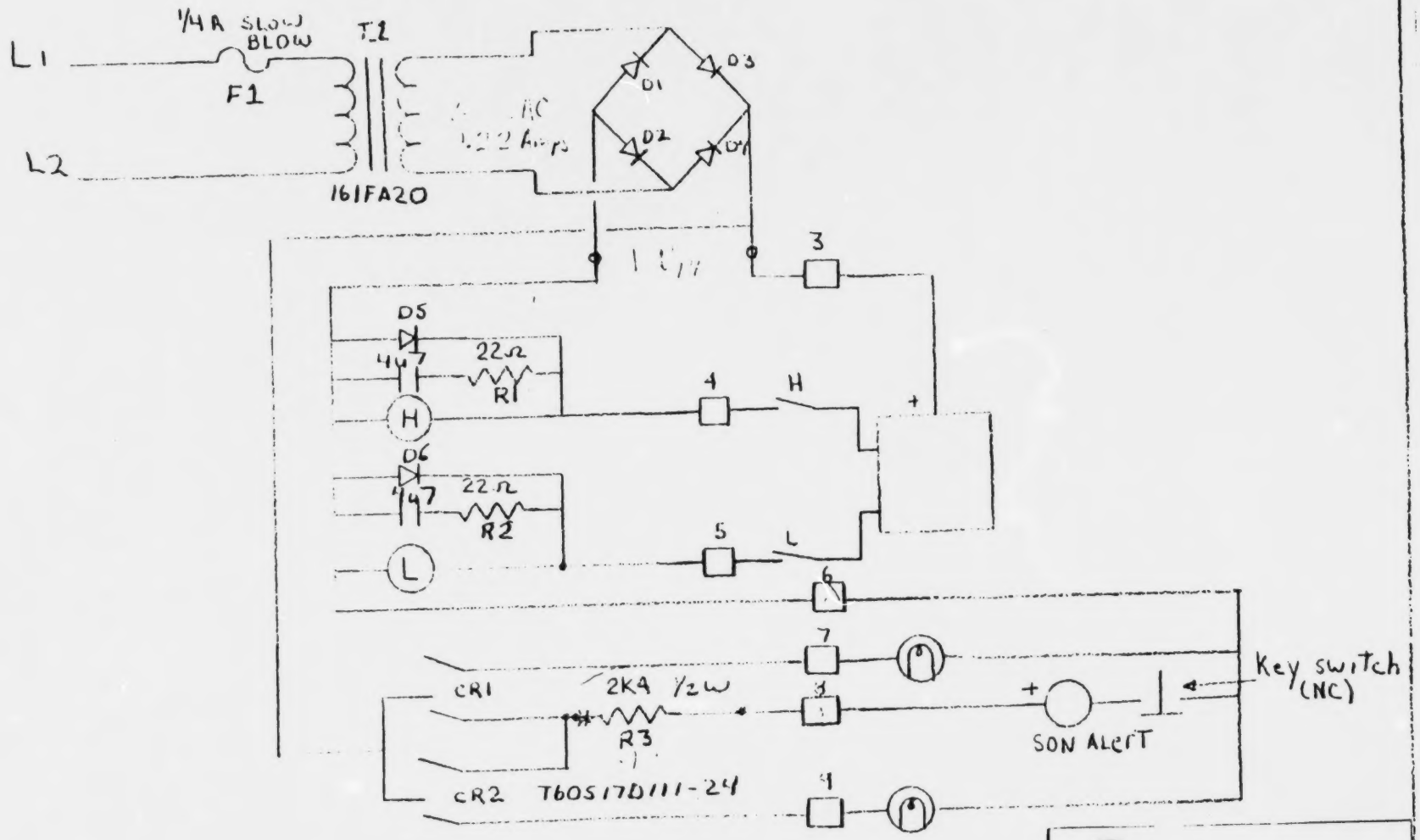
The value of the resistor should be adequate to give a reasonable voltage change over the current range used. 200 ohms 1% is supplied to give a voltage range of 800 mV to 4 V, for a current change from 4 to 20 mA, and the indicators are connected for use on the 500 mA to 5V ranges.

These may be changed as desired, see the enclosed Daytronic Manuals.

OPERATION

Operation with a signal lower than the low set point causes the amber lamp on the front panel to light and operation above the high set point causes the red lamp to light.

Unless cancelled by the key operated switch the audible alarm operates when either set point is exceeded.

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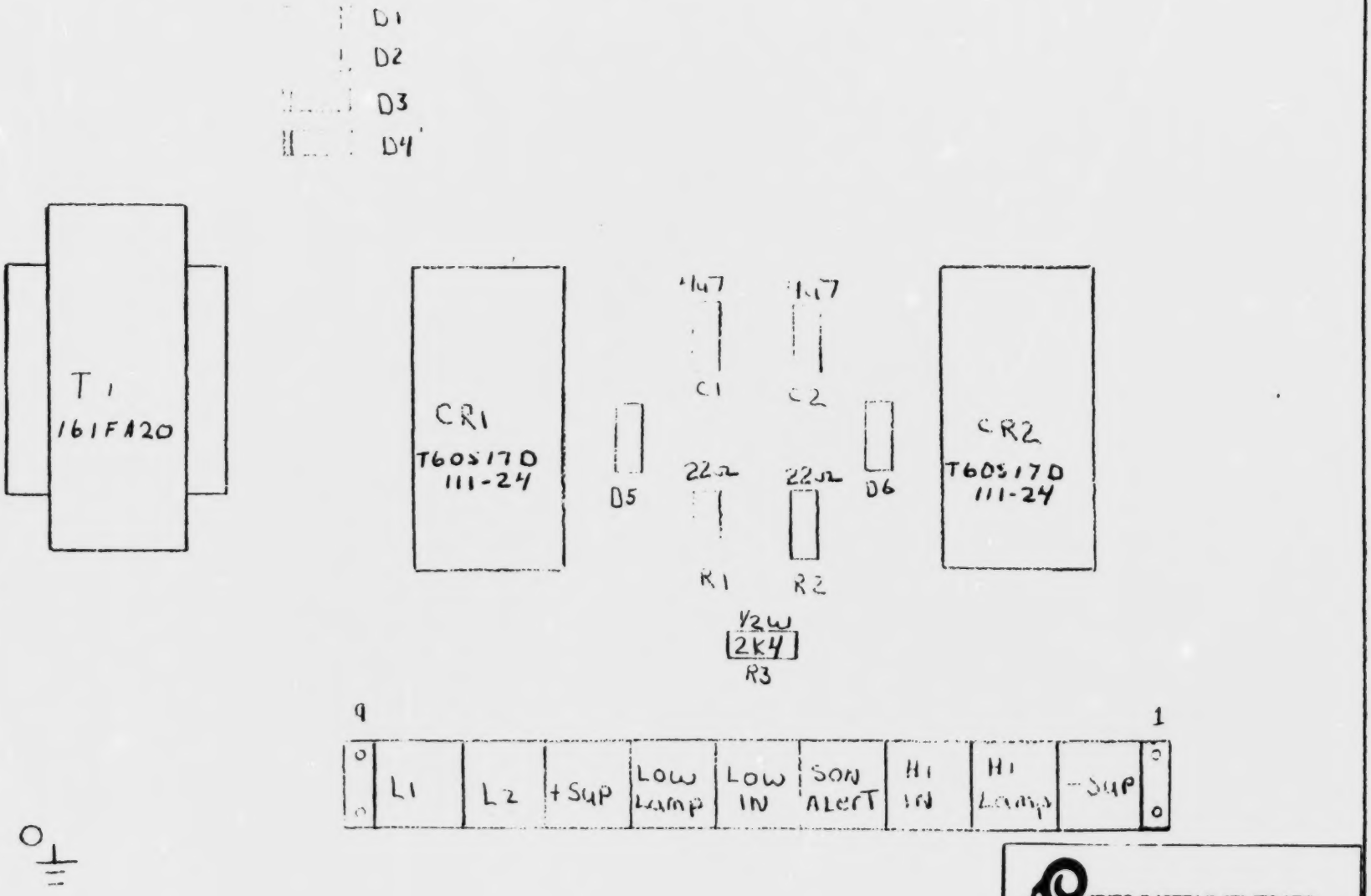
Power Supply

DWG W. S. WALLACE

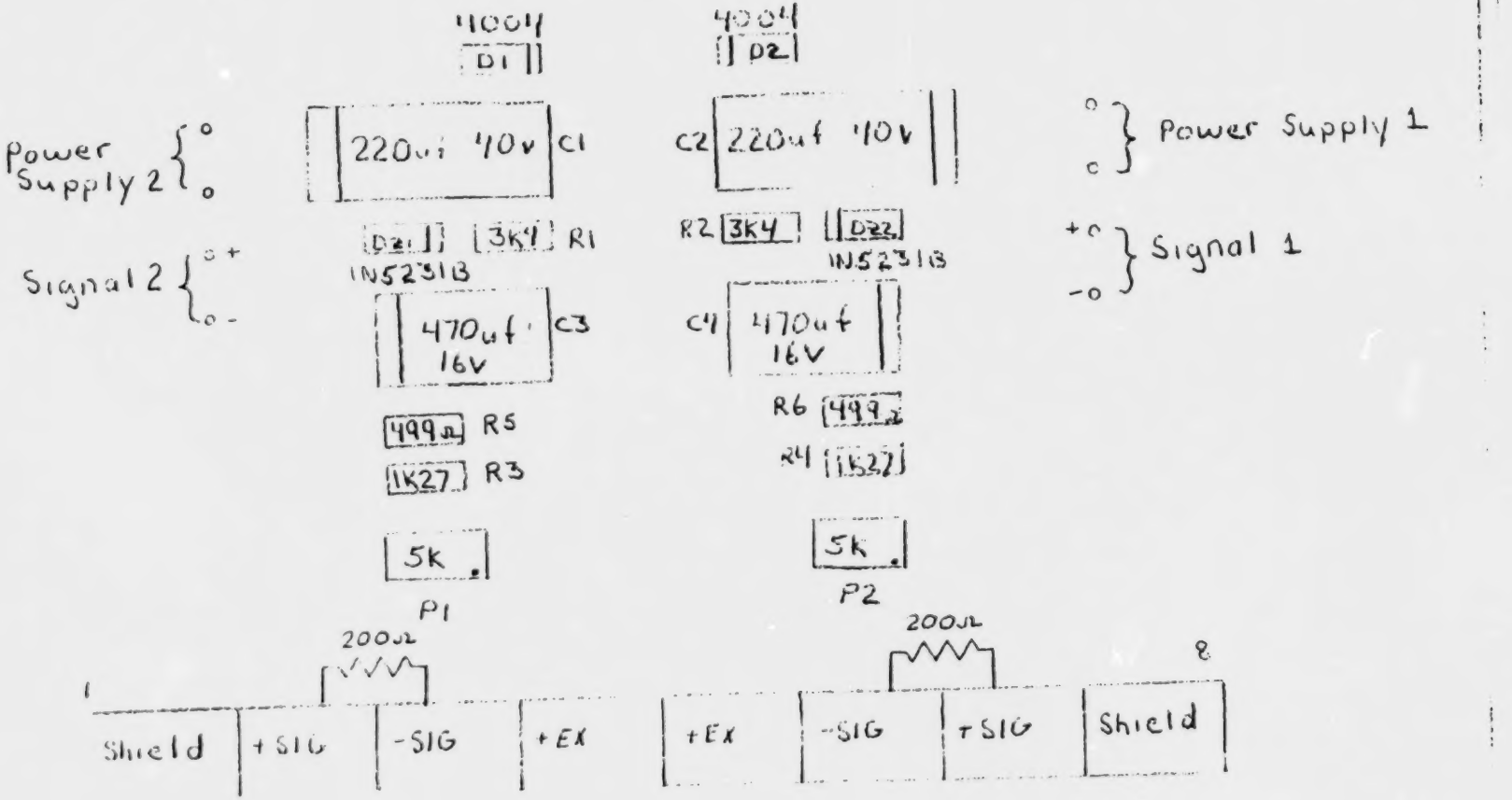


85-162




ARIES INSTRUMENTS LTD.
P.O. Box 662 PICKERING, ONTARIO L1V 3T3

POWER SUPPLY
WSWALLACE

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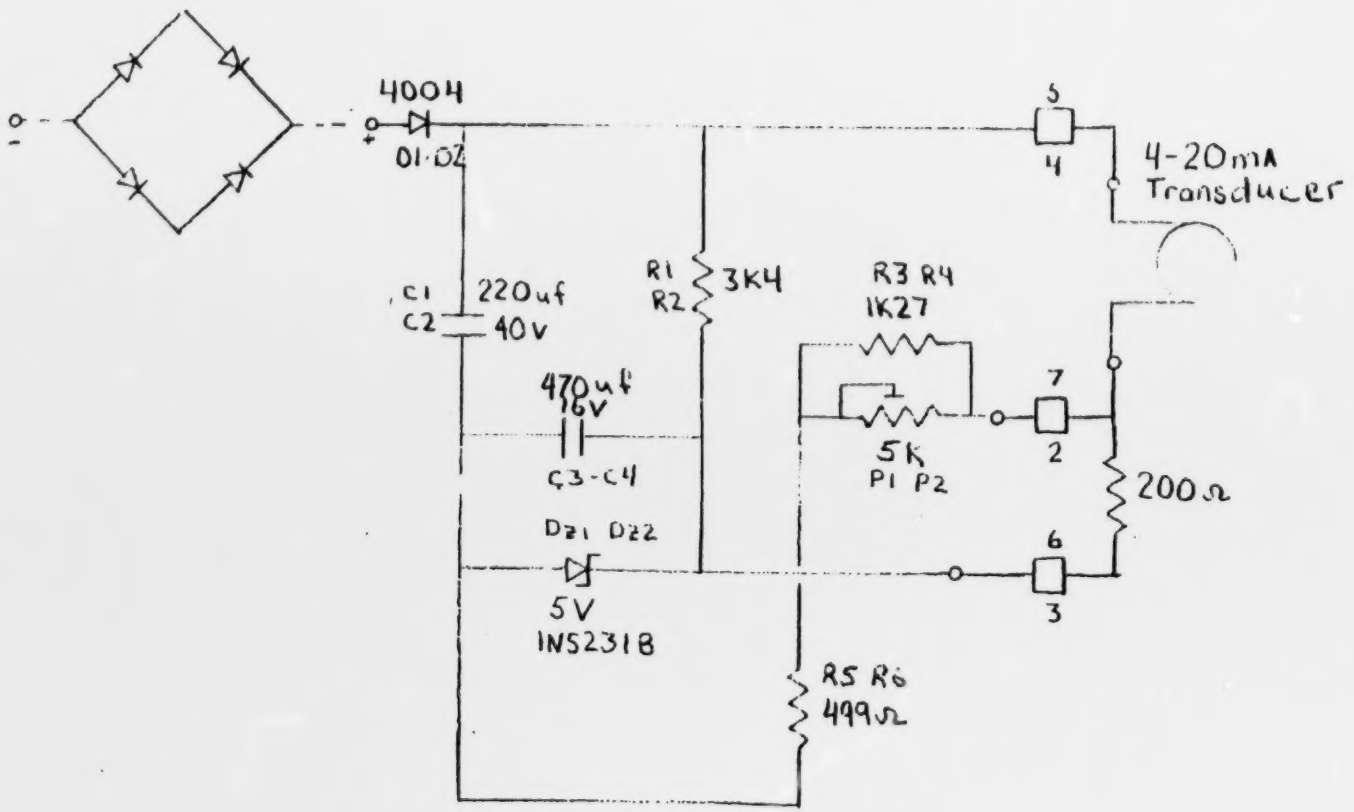
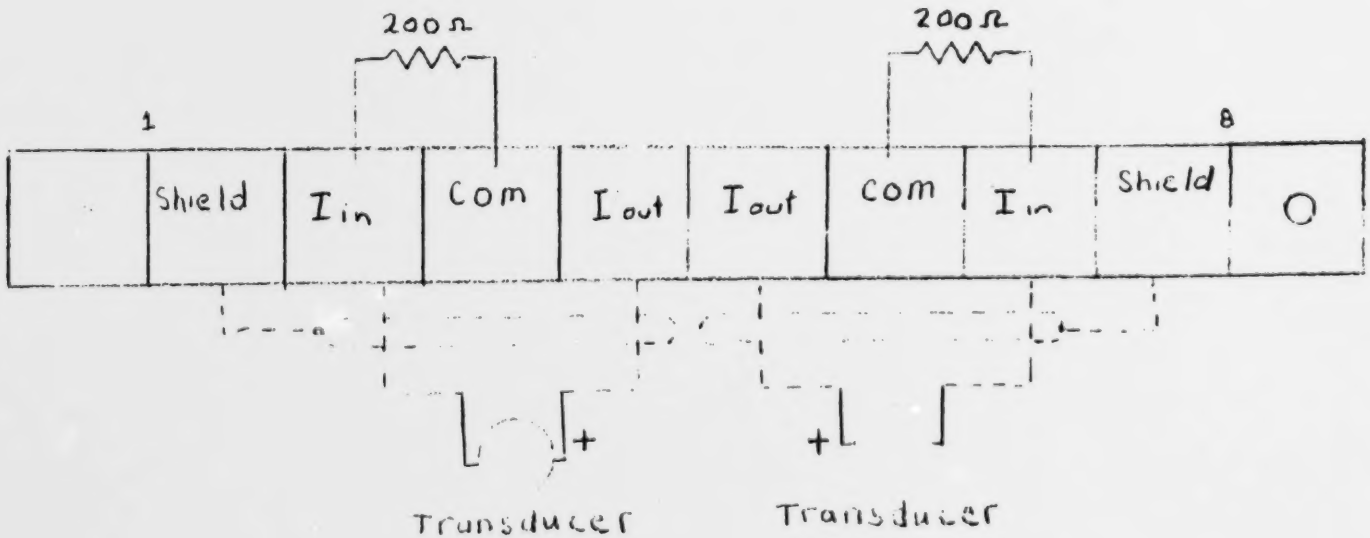
COURSE ZERO ADJUST

DWG W.S. WALLACE



85-162


4004
D1-D2
C1
C2
220uf
40V
R1
R2
3K4
R3 R4
1K27
470uf
16V
C3-C4
5K
P1 P2
200Ω
D21 D22
5V
IN5231B
R5 R6
499Ω
4-20mA
Transducer
5
4
7
1
2
6
3
- 34 -
85-162
main Terminal
other board
ARIES INSTRUMENTS LTD.
P.O. Box 662, PICKERING, ONTARIO L1V 3T3
COURSE ZERO ADJUST
DWG W.G. WALLACE




Note: Com = -Ex-SIG

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P.O. Box 662 PICKERING, ONTARIO L1V 2T3

TERMINAL STRIP

W.S. WALLACE

"3000" Series
Instruments
Instruction Manual
December 1982

# Model 3300
# Hi-Lo Limits

Daytronic Corporation • 2589 Corporate Place • Miamisburg, OH 45342 • 513/866-3300

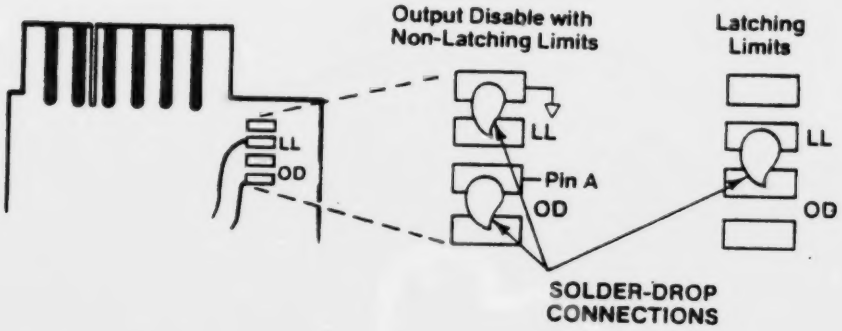
DAYTRONIC

*Manufacturer of Intelligent Instrument Systems*

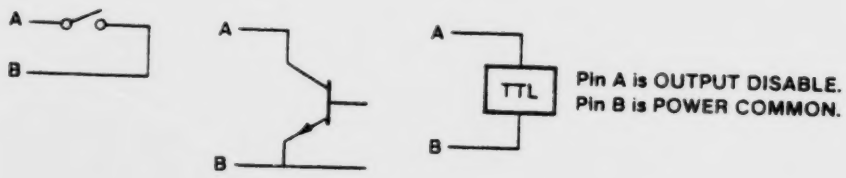
**NOTE**

The Model 3300 may operate in either of two modes: *Latching Limits* (LL), where limit logic outputs are held until application of an external *Reset* action, or *Output Disable* (OD), where limit logic outputs are *non-latching*, being automatically disabled as soon as the *Violation* condition ceases.

Unless you have specified otherwise, your Model 3300 will have been preset *at the factory* for *non-latching* operation, through solder-drop terminals on the underside ("Side 1") of the printed-circuit board, as shown below. You may at any time, however, resolder the terminal connections as shown to produce *latching* limit outputs.




For *latching* operation, you must also provide an external means of resetting the limit outputs as soon as the condition(s) giving rise to the violation have ceased to exist, thus resetting the 3300 to continue normal limit monitoring. To reset *latched* limit outputs, Pins A and B of the *Limit output connector* (see Table 3, p. 8) must be connected by one of the three methods shown below:




In all discussions of limit logic outputs in this manual, "normal" — i.e., *Output Disable* — operation of the Model 3300 is presumed.

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3 3.

# INSTRUCTION MANUAL
# 3300 SERIES HI-LO LIMITS

## 1. DESCRIPTION

The *3000 Instrument Series* is a family of premium signal conditioning instruments that includes models to accomodate virtually all types of transducers and signal sources commonly encountered in electro-mechanical testing and control operations. The *3000 Instruments* are available in three forms: *Form 1* contains the Signal Conditioner only; *Form 2* is the Signal Conditioner with Digital Indicator; *Form 3* is the Signal Conditioner with Digital Indicator and Hi-Lo Limits. The model numbering system used with the *3000 Series* identifies the form and the type of signal source. This numbering system is further explained in Table 1. From Table 1, it can be seen that all models having Hi-Lo Limits are identified by a 33XX number, with the last two digits identifying the type of signal source (thermocouple, LVDT, etc).

*Figure 1. 3000 Series Instrument with Hi-Lo Limits*

*Table 1. 3000 Series Model Numbering*

**Model 3 X X X**

**"3" is series identifier, used with all units:**

**Second digit identifies "form":**

"1" = signal conditioner only
"2" = signal conditioner with digital indicator
"3" = signal conditioner with digital indicator and Hi-Lo limits

**Third and fourth digits identify type of signal source:**

"10" = Type J Thermocouple
"11" = Type K Thermocouple
"15" = Thermistors
"30" = LVDT's
"40" = Pulse Pick-up's (Frequency)
"63" = DC Volts/Millivolts/ DC-DC LVDT's/Potentiometers
"70" = Strain Gages (DC excited)
"78" = Strain Gages (AC excited)
Etc.

The *3000 Series* instruction manual system is designed to provide the user with the following documentation: (1) a separate instruction manual for each type of Signal Conditioner purchased; (2) an instruction manual covering only the Digital Indicator section of a *3000 Series* instrument, but applicable to any *Form 3* instrument. It is the purpose of this manual to cover the Hi-Lo Limit section of all *Form 3* instruments.

The Hi-Lo Limit section of any *Form 3* instrument consists of the following: (1) an additional printed-circuit board on which are mounted the required circuit components for Hi-Lo Limit operation, (2) associated front-panel controls and indicators, and (3) a rear-panel connector where the *Limit* mode is selected and where *Limit* logic outputs can be obtained.

The *3300 Series* instruments can be used in any of three *Limit* modes. The *Low/OK/High* is the most common mode of operation and is used to detect when the analog signal drops below a *Low* limit or exceeds a *High* limit. The range in between limits is designated as *OK*. The second mode which can be used is the *Both Limits High* mode where both limits are above the *OK* range. The third mode is the opposite function, or the *Both Limits Low* mode, where both limits are below the *OK* range. In all three modes of operation, the limits can be set across the entire ± signal range (±5 volts). The instrument is shipped for operation in the *Low/OK/High* mode, but either of the other two modes can be easily selected by wiring of the rear-panel *Limit* output connector (see Section 2, Installation).

Both true and complement limit logic outputs are available at the *Limit* output connector for the *Low/OK/High* functions. The outputs are wire-ORable, TTL compatible (10 milliamperes sink, 0.5 milliamperes source). For *latching* limits, see NOTE, inside front cover.

Front-panel status indicators light to indicate when a limit is exceeded or when the analog signal is within the *OK* range. A red LED is used for each of the limits and a green LED is used as the *OK* indicator.

*Coarse* and *Fine* setting potentiometers are provided for each limit. Individual *Push-to-Set* buttons cause the limit value to be displayed by the Digital Indicator in the proper engineering units. A typical *3300 Instrument* is shown in Figure 1. The specifications for the *Limit* section are given in Table 2.

## 2. INSTALLATION

The *3000 Series* Instruments can be operated as bench-top instruments or they can be rack- or panel-mounted. Dimensions for all three types of mounting and corresponding mounting instructions are given in the accompanying Signal Conditioner *Instruction Manual*. The following paragraphs provide instructions for limit mode selection, input filtering, logic output connections, and ac power connection.

*Table 2. Specifications*

**Limit Status Display:** Individual red LED's indicate if limits are violated. Single green LED indicates no violations (analog signal within *OK* range).

**Limit Setting:** *Coarse* and *Fine* setting potentiometers provided for each limit. Individual *Push-to-Set* buttons also provided. When button is pushed, limit is displayed in proper engineering units on Digital Indicator.

**Limit Logic Outputs:** Both true and complement outputs provide for *Low/ OK/ High* functions. Outputs are TTL compatible, wire ORable; 10 ma sink, 0.5 ma source (max). Logic outputs are normally disabled when violation ceases to occur, but *latching* mode is also available (see NOTE, inside front cover).

**Limit Modes:** Three modes are available thru rear-panel *Limit* output connector wiring. Units shipped with *Low/OK/High* mode activated. *Both Limits High* or *Both Limits Low* mode can be user selected.

**Output Disable:** An *Output Disable* line provided which, if tied low, will cause all *limit* logic outputs to go high (both true and complement for each function).

**Limit Mode Selection.** Figure 2 illustrates the three modes in which *3300* Instruments can be operated. The unit is shipped from the factory with the *Low/ OK/High* mode activated. In this mode, the *Low* limit is set some increment below the *High* limit. The increment between limits is the *OK* range. Either limit can be set positive or negative, as long as the *Low* limit is more negative than the *High* limit. When the *High* limit is exceeded, the front-panel LED status indicator (red) marked HIGH will light. When the analog signal drops below the *Low* limit, the front-panel LED status indicator (red) marked LOW will light. When the signal is between the two limits, the front-panel status indicator (green) marked OK will light. In this mode, only one of the three status indicators will light at any one time.

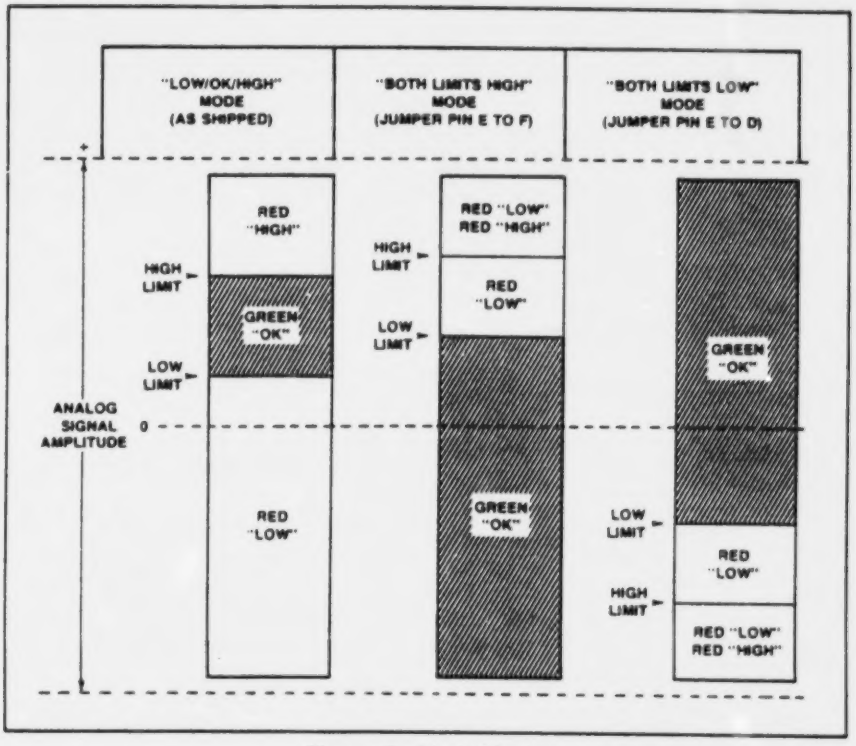



*Figure 2. Limit Modes*

To activate the *Both Limits High* mode, jumper pin E to pin F at the supplied rear-panel *Limit* output connector. In this mode, the limits can also be set positive or negative, as long as the *High* limit is set some increment more positive than the *Low* limit. When the analog signal is below or more negative than the *Low* limit, the green OK indicator will light. When the *Low* limit is exceeded, the red LOW indicator will light (green OK will extinguish). When the *High* limit is exceeded, the red HIGH indicator will light and the red LOW indicator will remain lit to indicate that now both limits are exceeded. When the signal drops below the *High* limit (but not the *Low* limit), the LOW indicator will remain lit. When the signal drops below the *Low* limit, the LOW indicator will extinguish and the OK indicator will again light to indicate no violations.

5

## "3000" Hi-Lo Limits

To activate the *Both Limits Low* mode, jumper pin E to pin D at the *Limit* output connector. In this mode, the limits can also be set positive or negative, as long as the *High* limit is set some increment more negative than the *Low* limit. This mode works exactly opposite to that described in the preceding paragraph. When the analog signal is above or more positive than the *Low* limit, the green OK indicator will light. When the signal drops below the *Low* limit, the red LOW indicator will light (green OK will extinguish). When the signal drops below the *High* limit, the red HIGH indicator will light and the red LOW indicator will remain lit to indicate that now both limits are violated. When the signal rises above the *High* limit (but not the *Low* limit), only the LOW indicator will remain lit. When the signal rises above the *Low* limit, the LOW indicator will extinguish and the OK indicator will again light to indicate no violations.

**Input Filtering.** Two filtered outputs are brought from the Signal Conditioner printed-circuit board to the Limit printed-circuit board. Both are low-pass filter outputs, with one having a cutoff frequency of 200 Hz (*fast* signal) and the other having a cutoff frequency of 2 Hz (*slow* signal). The *fast* signal is normally connected to the Limit board circuitry via a solder-drop terminal labelled *F* on the underside (*Side 1*) of the Limit board (all 3300 units are shipped with this connjection made). Instrument operation should be attempted without removing this connection. However, if excessive limit *chattering* is encountered (transducer is subject to excessive vibration etc.), this connection should be removed and the *slow* signal terminals should be connected via a solder-drop. The *fast* and *slow* signal solder-drop terminals are illustrated in Figure 3.

**Logic Output Connections.** Logic outputs are provided at the *Limit* output connector for the *Low/OK/High* functions. Both true and complement outputs are provided that are TTL compatible (10 millamperes sink, 0.5 millamperes source maximum). These outputs may be used to trigger alarms or sort/reject devices etc. Typical wiring to these outputs to obtain a contact closure is shown in Figures 4 and 5. In Figure 4, wiring to a Daytronic 9399 Triac Controller is illustrated. Notice that while a variety of logic configurations can cause a contact closure, that current is always sinked by the *3300* instrument. If a device other than the 9399 is used, a resistor must be placed in series with the +5 volt line from the 3300 to limit the sink current to 10 milliamperes maxium.

Figure 5 shows the wiring and external circuitry when it is desired to close an external relay contact using source current. Only a Q output is used in this configuration and the source current drawn must be limited to 0.5 milliamperes maximum.

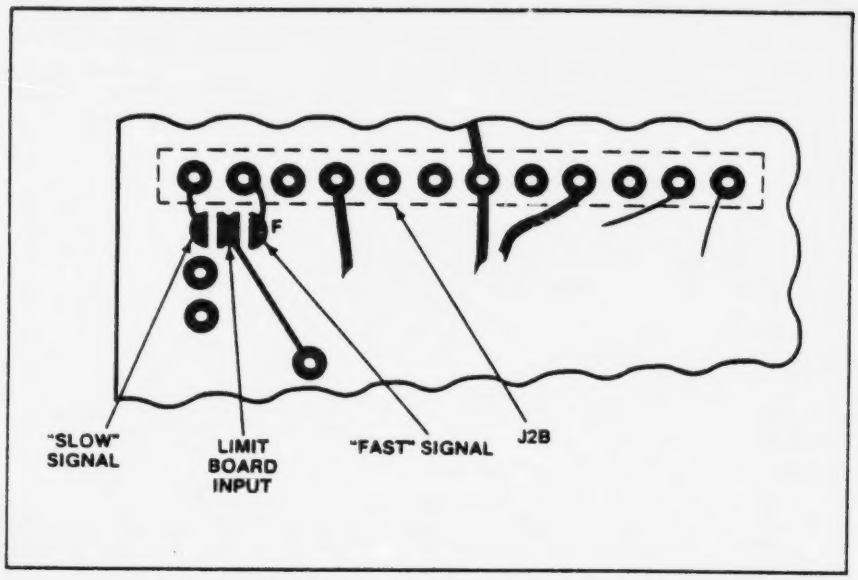



*Figure 3. Fast/Slow Signal Solder-Drop Terminals*

An *Output Disable* is also provided at the *Limit* output connector (pin A). When pin A is jumpered to pin B (common), all logic outputs (true and complement) are held high (+5 volts). Table 3 gives a listing of the functions available at the *Limit* output connector and the corresponding pin numbers.

**AC Power Connection.** To protect operating personnel, the *3000 Series* Instruments are equipped with a three-conductor power cord. When the cord is plugged into the appropriate receptacle, the instrument is grounded. The offset pin on the power cord is ground. To maintain the safety ground when operating the instrument from a two-contact outlet, use a three-prong to two-prong adaptor and connect the green pigtail on the adaptor to ground.

To prepare the instrument for operation, connect the power cable to a 105-135 volt ac, 50-400 Hz power source. The instrument can use up to 5 watts of power.

*Table 3. Limit Output Connector Functions/Pin Nos.*

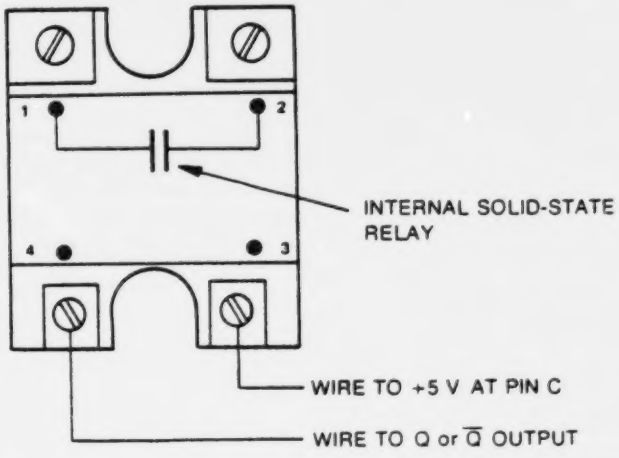
| Function | Pin Number |
|---|---|
| +5 volts | C |
| Common | B |
| Limit Select | E |
| Both Lo | D |
| Both Hi | F |
| Output Disable | A |
| $Q_{Lo}$ | 5 |
| $\overline{Q}_{Lo}$ | 6 |
| $Q_{Hi}$ | 1 |
| $\overline{Q}_{Hi}$ | 2 |
| $Q_{OK}$ | 3 |
| $\overline{Q}_{OK}$ | 4 |

**Note:** Jumper E to F to enable *Both Limits High* mode. Jumper E to D to enable *Both Limits Low* mode. No connection to E enables *Low/OK/High* mode.

## 3. OPERATION

The only operation required is turning ON/OFF ac power and setting the desired limits. These operations are described in the following paragraphs. Figure 6 provides a functional description of the front-panel.

**Power On/Off.** AC power is turned ON/OFF the instrument by means of a rear-panel slide switch. The digital display lights immediately when ac power is ON.




1. Wire pin 4 of 9399 to $\overline{Q}_{Hi}$ or $\overline{Q}_{Lo}$ output for contact closure at violation of limit.
2. Wire pin 4 of 9399 to $Q_{Hi}$ or $Q_{Lo}$ output for contact closure with no violation.
3. Wire pin 4 of 9399 to $\overline{Q}_{OK}$ output for contact closure with no violation.
4. Wire pin 4 of 9399 to $Q_{OK}$ output for contact closure at violation.
5. If Triac Controller other than 9399 is used, make certain sink current does not exceed 10 ma for TTL outputs.

*Figure 4. Model 9399 Triac Controller Wiring*

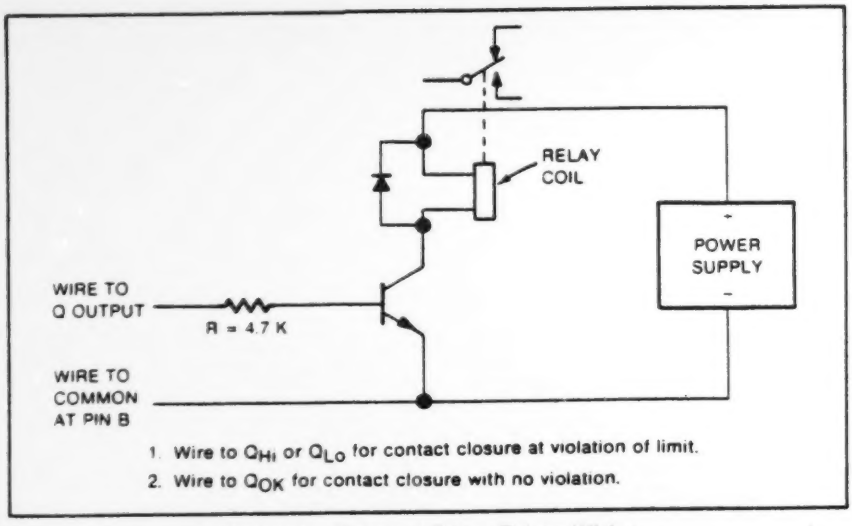


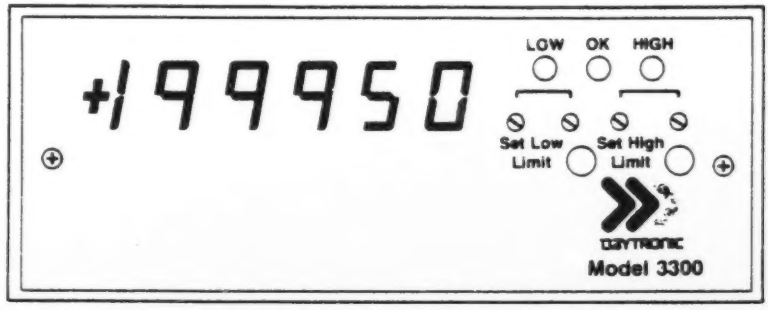

*Figure 5. External Relay Driver Wiring*

**Limit Setting.** Before setting the *Low* and *High* limits, the user should refer to Section 2 of this manual and become familiar with the limit mode in which the instrument is to be operated. Figure 2 illustrates the three operating modes by giving a graphic representation of typical limit settings. The *Limit* logic outputs wiring should also be reviewed before attempting to operate the instrument. This information is also contained in Section 2. To prevent inadvertent triggering of external circuits while setting the limits, remove the rear-panel *Limit* output connector. The connector can then be replaced after the proper limits have been set. To set the limits, proceed as follows:

(a) Press the *Set Low Limit* button and adjust the *Coarse* and *Fine Low* limit controls until the desired *Low* limit value is displayed on the Digital Indicator.

(b) Press the *Set High Limit* button and adjust the *Coarse* and *Fine High* limit controls until the desired *High* limit value is displayed on the Digital Indicator.

(c) The limits are now set and the appropriate LOW and HIGH status indicators will light when a violation of the limit occurs. The OK indicator will be lit when there is no violation. **NOTE:** For the front-panel status indicators to have meaning as marked, the *Low* limit must be set more negative than the *High* limit in the *Low/OK/High* and *Both Limits High* modes. In the *Both Limits Low* mode, the *Low* limit must be set more positive than the *High* limit for the terminology to have meaning.




**LOW Status Indicator:** Red LED which lights to indicate when *Low limit* is violated.

**OK Status Indicator:** Green LED which lights to indicate when limits are not violated.

**HIGH Status Indicator:** Red LED which lights to indicate when *High* limit is violated.

**Coarse and Fine Limit Controls:** Individual controls are provided for setting the *High* and *Low* limit values.

**Set Low Limit Button:** When pressed, causes the *Low* limit value to be displayed on the Digital Indicator.

**Set High Limit Button:** When pressed, causes the *High* limit value to be displayed on the Digital Indicator.

*Figure 6. Front-Panel Description*

## 4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Limit circuits work by using a simplified block diagram. This section is not intended to provide a detailed explanation of electronic circuits for personnel untrained in electronic technology. However, it provides an adequate overview of operation for those familiar with basic electronic circuit operation. Throughout the following, refer to Figure 7.

A +2.5 volt precision *Reference* is supplied from a precision power supply located on the Signal Conditioner circuit board. This *Reference* is supplied as an input to a non-inverting amplifier from which the voltages are developed which are used for limit setting. A +5.6 volt level is obtained at the output of the *Reference Amplifier* and a −5.6 volt level is generated through the use of a *Unity Gain Inverter*. The ±5.6 volt levels are then applied across the *Fine* and *Coarse* limit potentiometers. The potentiometer wipers are summed together, then applied as non-inverting inputs to *Buffer Amplifiers* (one for the *Low Limit* channel and one for the *High Limit* Channel). Each *Buffer Amplifier* output is wired to a normally-open contact of a *Set Limit* pushbutton. When either pushbutton (*Set Low Limit* or *Set High Limit*) is pressed, the limit value is connected as an input to the Digital Indicator (analog output from the Signal Conditioner is disconnected from the Digital Indicator input). While the limit value is displayed on the Digital Indicator, the appropriate value can be set with the *Fine* and *Coarse* limit potentiometers. The *Buffer Amplifier* outputs are applied as inputs to a pair of voltage *Comparators*. The analog output from the Signal Conditioner is applied to each of the remaining *Comparator* inputs. When the signal is less than the limit set point, a *Comparator* output will be at a *logic 1* level (+9 volts). When the signal is greater than the limit set point, a *Comparator* output will be at a *logic 0* level (−9 volts).

Filtered outputs from the Signal Conditioner are applied to the Limit printed-circuit board. Both dc-to-200 Hz and dc-to-2 Hz analog outputs are provided. The 200-Hz signal is referred to as the *fast* signal and is normally connected to the limit circuits via a solder-drop connection. The 2-Hz signal, or *slow* signal, can be connected as an input to the limit circuits by unsoldering the *fast* signal solder terminal and soldering the *slow* terminal to the limit circuit input terminal. This is usually accomplished if limit *chattering* is encountered during operation. The *fast* signal is always connected to the limit input at factory fabrication.

Limit mode selection is accomplished by connecting the *Both Limits High* line or the *Both Limits Low* line to the *Limit Select* line (−9 volts) at the *Limit* output connector. The unit is shipped with neither of these connections made, automatically enabling the *Low/OK/High* mode. Exclusive OR logic is used to detect a violation. Two exclusive OR gates are used with a *60-Hz Filter* inserted between gates (diode-capacitor peak detector) to eliminate any ripple which might cause false triggering of the logic.

The first gate in the *Low Limit* channel has an input held low (thru an inverter whose input is tied high with a pull-up resistor) when the *Low/OK/High* mode is operational. When the analog signal is less than the set point, the remaining input to the gate is high. The gate output is consequently high. The second gate has one input tied low, thus its output is also high when the signal is less than the set point. Since this is the condition for a violation of the *Low* limit in the *Low/OK/High* mode, the LOW lamp (red LED) is lit through an inverter.

The first gate in the *High Limit* channel has an input held high (thru a pull-up resistor) when the *Low/OK/High* mode is operational. When the analog signal is greater than the set point, the remaining input to the gate is low. The gate output is consequently high. The second gate has one input tied low, thus its output is also high when the signal is greater than the set point. Since this is the condition for a violation of the *High* limit in the *Low/OK/High* mode, the HIGH lamp (red LED) is lit through an inverter.

The gated outputs of the *Low* and *High Limit* channels are ORed together to light the OK lamp (green LED). Both outputs must be low (no violation) to take the OR gate output high. With this output high, the OK lamp is lit through an inverter.

When the *Both Limits High* line is tied to the *Limit Select* line (−9 volts), the input to the first gate in the *Low Limit* channel is held high through the inverter. This reverses the logic and causes the *Low Limit* channel to be violated by an increasing analog signal. Operation of the *High Limit* channel remains as before, and the OK lamp lights when the signal is below both of the set points.

When the *Both Limits Low* line is tied to the *Limit Select* line, the input to the first gate in the *High Limit* channel is held low. This reverses the logic and causes

the *High Limit* channel to be violated by a decreasing signal. Operation of the *Low Limit* channel remains as in the *Low/OK/High* mode, and the OK lamp lights when the signal is above both of the set points.

Both true and complement outputs are provided for the *Low/OK/High* functions. These outputs are provided via a hex inverter chip with open-collector outputs. The open collectors are tied to +5 volts via pull-up resistors to provide TTL compatible outputs. An *Output Disable* line is provided which takes all outputs to +5 volts when tied to circuit common. This removes the +9 volts operating voltage from the hex inverter chip so that the outputs go to the pull-up resistor voltage of +5 volts.

The *±9 Volts Regulated* is supplied from power supplies contained on the Signal Conditioner circuit board. The *+5 Volts Regulated* is developed by a three-terminal *Regulator*. The *Unregulated* input to the *Regulator* is obtained from the Signal Conditioner circuit board (unregulated side of +9 volt supply). The +9 volt supplies are discussed in the Signal Conditioner *Instruction Manual*.

## 5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in rapidly determining whether the limit circuits are functioning normally or whether they are the source of the observed trouble. In the event a repair to the limit circuits is required, a complete parts list, schematic diagram, and component location drawing are included in this manual. The user may also contact the factory Service Department or the local Daytronic Representative for assistance.

(a) Make certain that the desired limit mode has been properly selected and that the limits have been set according to the front-panel terminology. The *Low* limit should be set more negative than the *High* limit in the *Low/OK/High* and *Both Limits High* modes. The *Low* Limit should be set more positive than the *High* limit when the *Both Limits Low* mode is used.

(b) Make certain that some input is provided to the Signal Conditioner so that the Digital Indicator is reading a value off zero in the direction of the *Low* limit.

(c) Adjust the *Coarse* and *Fine Low limit* controls until the LOW indicator lights. Using the *Fine* control, backoff the limit until the LOW indicator extinguishes; then, readjust the *Fine* control until the indicator lights again.

(d) Press the *Set Low Limit* button. The Digital Indicator should have the same reading that was previously displayed for the Signal Conditioner output. This indicates that it is possible to set a limit value equal to the Signal Conditioner Output and that the violation is being sensed.

(e) Increase the Signal Conditioner output toward the value of the *High* limit and repeat the procedure of steps (c) and (d) using the *High Limit* controls to check the *High* limit operation. If the *Low/OK/High* mode is being used, only one front-panel status indicator will be lit at any one time. The green OK indicator will light in the range between limits. If either of the remaining two modes are in use, when the HIGH indicator is lit, the LOW indicator will also be lit. When both the LOW and HIGH indicators are extinguished, the OK indicator will be lit.

(f) If the front-panel indications show that the limits are properly functioning, but external circuits are not being properly triggered, check the wiring to the *Limit* output connector. If a wiring error cannot be found, remove the external circuit connections and check the logic output levels while repeating steps (c) thru (e). Refer to table 3 for output functions and pin numbers of the *Limit* output connector. The Q outputs should be true (+5 volts) when the corresponding status indicator is lit.

## 6. CIRCUIT DIAGRAMS

Figure 9 is a detailed schematic/logic diagram of the Limit circuits. Figure 8 is a component placement drawing of the Limit circuit board. Components are located by reference designator.

## 7. REPLACEABLE PARTS

This section contains the information needed to order replacement parts for the Limit circuits. Table 4 gives the replaceable parts in reference designation order and gives the following information on each part:

(1) Description
(2) Daytronic Part Number

When ordering parts, include the description and Daytronic part number. Address orders or inquiries to:

Daytronic Corporation
2589 Corporate Place
Miamisburg, Ohio 45342

*Table 4. Replaceable Parts*

| REF DES | DESCRIPTION | MFR PART NO |
|---|---|---|
| **A4** | **PC Board: Limit Assembly 3300** | |
| A4C1 | Capacitor: fxd cer 1 μf 50 v | 23096 |
| A4C2, C3 | Capacitor: fxd cer 0.1 μf 50 v | 23117 |
| A4C5 | Capacitor: fxd cer 1 μf 50 v | 23096 |
| A4CR1 thru CR4 | Diode: Si 225 piv (1N645) | 24001 |
| A4CR5, CR6 | Diode: Ge 40 piv (1N56A) | 24006 |
| A4CR7, CR8 | Diode: Si 225 piv (1N645) | 24001 |
| A4DS1 | Lamp: LED (red) | 29091 |
| A4DS2 | Lamp: LED (green) | 29081 |
| A4DS3 | Lamp: LED (red) | 29091 |
| A4J2 | Connector: 14-pin socket strip | 74060 |
| A4Q1 thru Q4 | Transistor: Si NPN (2N3704) | 24064 |
| A4R1 | Resistor: var cermet 20 K 20 turns | 21109 |
| A4R2 | Resistor: fxd comp 3.3 meg 1/4 w 10% | 22325 |
| A4R3 | Resistor: fxd met flm 10 K 1/10 w 1% | 22135 |
| A4R4 | Resistor: fxd met flm 3.74 K 1/10 w 1% | 22255 |
| A4R5 | Resistor: fxd comp 10 meg 1/4 w 10% | 22269 |
| A4R6 | Resistor: fxd comp 11 meg 1/4 w 10% | 22401 |
| A4R7, R8 | Resistor: fxd comp 3.3 meg 1/4 w 10% | 22325 |
| A4R9 | Resistor: fxd met flm 3.74 K 1/10 w 1% | 22255 |
| A4R10 | Resistor: var cermet 25 K 1 turn | 21124 |
| A4R11, R12 | Resistor: fxd met flm 10 K 1/10 w 1% | 22135 |
| A4R13 | Resistor: fxd comp 220 1/4 w 10% | 22272 |
| A4R14 | Resistor: fxd comp 330 1/4 w 10% | 22265 |
| A4R15 | Resistor: fxd comp 220 1/4 w 10% | 22272 |
| A4R16 | Resistor: var ww 20 K 12 turns | 21104 |
| A4R17 | Resistor: var cermet 20 K 20 turns | 21109 |
| A4R18 | Resistor: fxd comp 3.3 meg 1/4 w 10% | 22325 |
| A4R19 | Resistor: fxd met flm 10 K 1/10 w 1% | 22135 |

*Table 4. Replaceable Parts (Cont.)*

| REF DES | DESCRIPTION | MFR PART NO |
|---|---|---|
| **A4** | **PC Board: Limit Assembly 3300 (Cont.)** | |
| A4R20 | Resistor: fxd comp 1 meg 1/4 w 10% | 22252 |
| A4R21 | Resistor: fxd comp 10 K 1/4 w 10% | 22241 |
| A4R22 | Resistor: fxd comp 390 1/4 w 10% | 22268 |
| A4R23 | Resistor: fxd comp 10 K 1/4 w 10% | 22241 |
| A4R24 | Resistor: var ww 20 K 12 turns | 21104 |
| A4R25 | Resistor: fxd met flm 3.74 K 1/10 w 1% | 22255 |
| A4R26 | Resistor: fxd comp 10 meg 1/4 w 10% | 22269 |
| A4R27 | Resistor: fxd comp 11 meg 1/4 w 10% | 22401 |
| A4R28, R29 | Resistor: fxd comp 3.3 meg 1/4 w 10% | 22325 |
| A4R30 | Resistor: fxd met flm 3.74 K 1/10 w 1% | 22255 |
| A4R31 | Resistor: var cermet 25 K 1 turn | 21124 |
| A4R32 | Resistor: fxd met flm 12.4 K 1/10 1% | 22260 |
| A4R33 | Resistor: fxd met flm 10 K 1/10 w 1% | 22135 |
| A4R34 | Resistor: fxd comp 10 K 1/4 w 10% | 22241 |
| A4R35 | Resistor: fxd comp 1 M 1/4 w 10% | 22252 |
| A4R36 thru R39 | Resistor: fxd comp 10 K 1/4 w 10% | 22241 |
| A4RN1 | Resistor network: 10 K | 22358 |
| A4U1 | Integrated Circuit: 5 volt reg (MC7805CP) | 44046 |
| A4U2 | Integrated Circuit: qual op amp (TL064) | 44141 |
| A4U3 | Integrated Circuit: dual hi perf op amp (MC1458CP) | 44039 |
| A4U4 | Integrated Circuit: quad excl OR (CD4070BE) | 44061 |
| A4U5 | Integrated Circuit: hex Schmitt trigger (MM74C914) | 44210 |
| A4U6 | Integrated Circuit: com cath LED digit driver (NE582) | 44125 |
| | **Mechanical Parts** | |
| | front glass (3370) | 35060.1 |
| | front glass (3340) | 35060.2 |
| | front glass (3330) | 35067.1 |
| | front glass (3378) | 35068.1 |
| | front glass (3310) | 35071.1 |
| | rear panel | 71332.1 |
| | hi-lo limits pc board | 73473 |

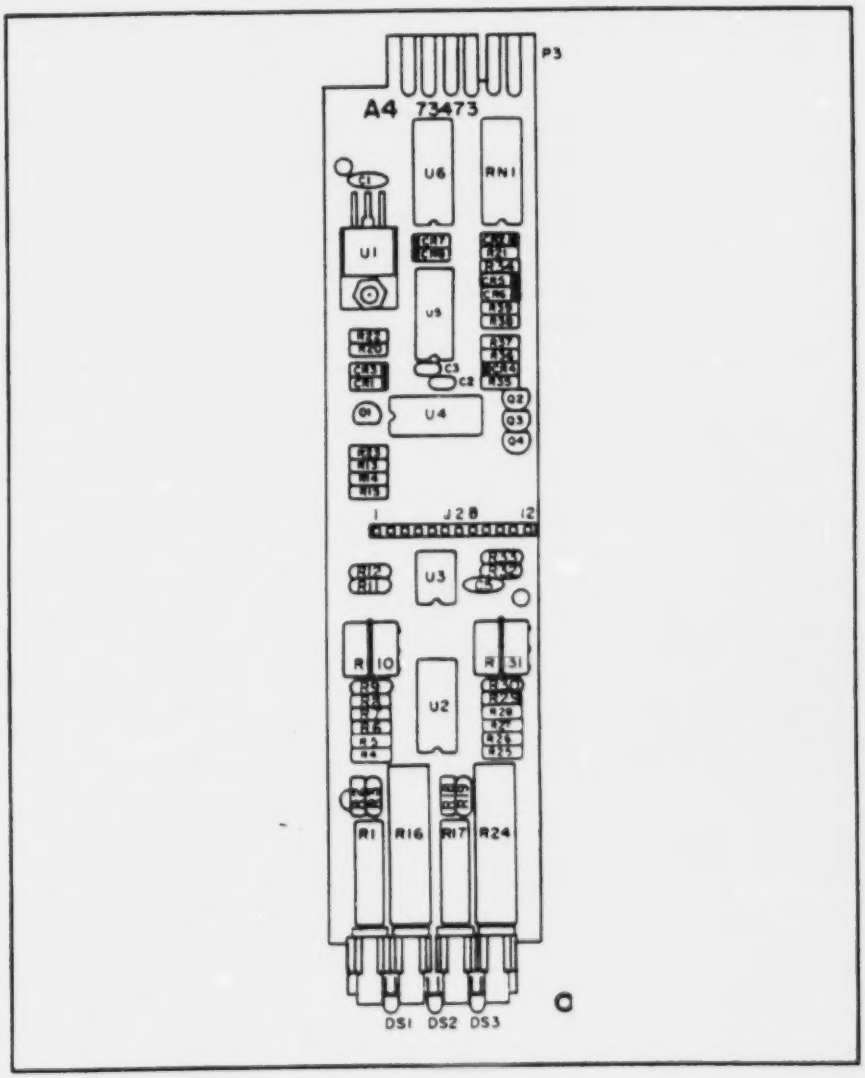
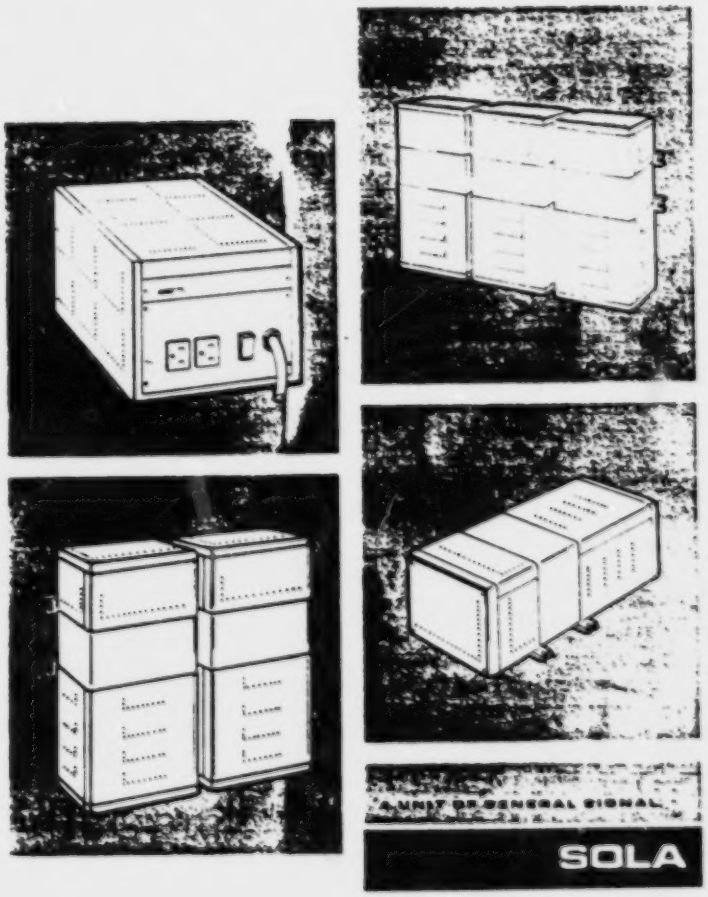



*Figure 8. Limit Board*

# MICRO/MINICOMPUTER REGULATORS

## OPERATING AND SERVICE MANUAL



**OPERATING & SERVICE INSTRUCTIONS**
**SOLA MICRO/MINICOMPUTER REGULATORS**
**U.L. WHITE CARD LISTED — POWER SUPPLY CLASSIFICATION[1]**
**C.S.A. CERTIFIED — TRANSFORMER CLASSIFICATION[2]**

# GENERAL DESCRIPTION & SPECIFICATIONS

The Sola Micro/Minicomputer Regulator provides virtually instantaneous voltage regulation, and isolation from both transverse and common mode noise for any type of load. It also suppresses transients, protects against overloads and serves as a portable dedicated line. It is the ultimate in AC power conditioning equipment.

The portable 70 to 3000 VA models are designed for office type environments and have a low acoustical sound level of 43 dB. Also available are hard-wired models for heavy-duty applications in the 120 to 15000 VA range.

**Operating Temperature Range:** −20° to +50° C.

**Phase:** Single

**Input Voltage (Portable models):** 95-130 Vac (60-Hz Models) or 180-260 Vac (50-Hz Models)

**Input Voltage (Hard-Wired models):** Refer to Table 3

**Output Voltage (Portable models):** 120 Vac (60-Hz Models) or 220/240 Vac (50-Hz Models)

**Output Voltage (Hard-Wired models):** 120, 208, or 240 Vac

**Output Voltage Regulation:** ±3% for an input line variation of ±15%.

**Output Harmonic Distortion:** Less than 3% total rms content at full load.

**Efficiency:** 85% @ full load. No loss of output for line loss of 3 msec.

Common mode noise rejection exceeds 120 dB.

Transverse mode noise rejection exceeds 60dB.

Output will remain within NEMA voltage specifications for input voltages as low as 65% of nominal.

# INSTALLATION

All regulators generate considerable heat and depend on the natural draft air circulation for adequate cooling. It is important that ventilation openings not be obstructed. Mounting in a confined or poorly ventilated space should be avoided unless special provisions have been made for ventilation.

Portable regulators, 3 kVA and smaller, are equipped with one input off-on switch, one 3-wire grounding type input cord/plug and two or more 3-wire grounding output receptacles. No additional connections are required except for customer's output cable(s). The neutral side of the output voltage is grounded to the regulator chassis, as are the input cord and output receptacle ground connections. Figure 1 (in conjunction with Tables 1 and 2) presents dimensional data. A schematic diagram is presented in Figure 2(a) for 60-Hz Models and Figure 2(b) for 50-Hz Models.

[1] 50-Hz models are not U.L. listed.
[2] 60-Hz portable models, 70-2000 VA, are C.S.A. certified. Consult factory for latest approval status.

* Refer to Table 1.

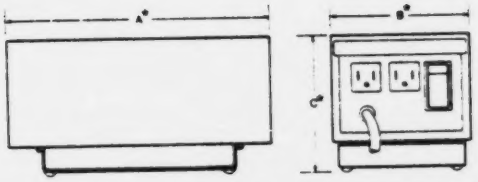



**Figure 1. Portable Micro/Minicomputer Regulators**

**Table 1. Portable Micro/Minicomputer Regulators — 60Hz Models**

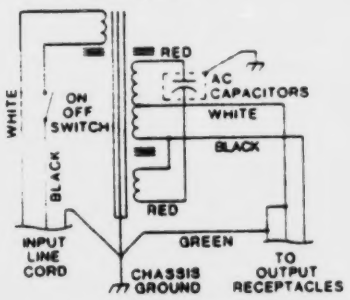
| Catalog Number | Output VA Rating | Approximate Shipping Weight (Lbs) | Dimensions* (Inches) | | | Receptacle | | Plug |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | NEMA | Qty | NEMA |
| 63-13-070 | 70 | 16 | 12.06 | 6.00 | 5.94 | 5-15R | 2 | 5-15P |
| 63-13-114 | 140 | 20 | 12.06 | 6.00 | 5.94 | 5-15R | 2 | 5-15P |
| 63-13-124 | 250 | 34 | 13.62 | 8.12 | 7.25 | 5-15R | 2 | 5-15P |
| 63-13-150 | 500 | 44 | 16.62 | 8.88 | 8.44 | 5-15R | 2 | 5-15P |
| 63-13-175 | 750 | 53 | 16.62 | 8.88 | 8.44 | 5-15R | 2 | 5-15P |
| 63-13-210 | 1000 | 63 | 16.62 | 8.88 | 8.44 | 5-15R | 4 | 5-15P |
| 63-13-220 | 2000 | 117 | 16.88 | 11.38 | 10.62 | L5-30R | 2 | L5-30P |
| 63-13-230 | 3000 | 150 | 16.88 | 11.38 | 10.62 | L5-30R | 2 | 5-50P |
| | | | | | | 5-15R | 2 | |

*Refer to Figure 1.

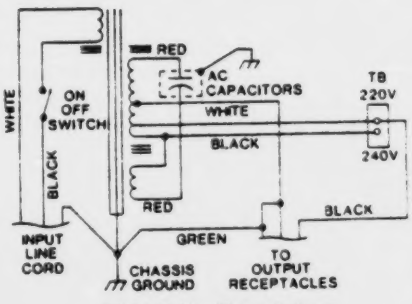
**Table 2. Portable Micro/Minicomputer Regulators — 50Hz Models**

| Catalog Number | Output VA Rating | Approximate Shipping Weight (lbs) | Dimensions* (Inches) | | | Receptacle | | Plug |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | NEMA | Qty | NEMA |
| 63-13-570-2 | 70 | 24 | 12.06 | 6.00 | 5.94 | 6-15R | 2 | 6-15P |
| 63-13-614-2 | 140 | 28 | 13.62 | 8.12 | 7.25 | 6-15R | 2 | 6-15P |
| 63-13-625-2 | 250 | 38 | 13.62 | 8.12 | 7.25 | 6-15R | 2 | 6-15P |
| 63-13-650-2 | 500 | 46 | 16.62 | 8.88 | 8.44 | 6-15R | 2 | 6-15P |
| 63-13-710-2 | 1000 | 72 | 16.62 | 8.88 | 8.44 | 6-15R | 2 | 6-15P |
| 63-13-720-2 | 2000 | 122 | 16.88 | 11.38 | 10.62 | 6-15R | 2 | 6-15P |

* Refer to Figure 1.




2(a) 60-Hz Regulators




2(b) 50-Hz Regulators

**Figure 2. Portable Micro/Minicomputer Regulators — Schematic Diagrams**

3

**Caution**

**50-Hz portable models are factory-wired for 220 Vac output. To convert regulator to 240 Vac output, perform the following procedure.**

To change the output voltage of 50-Hz portable regulators, remove the small Sola logo strip across the front panel. Then remove the front panel to expose a terminal block. Disconnect the lead to the front panel outlets and connect it to the appropriate terminal.

Hard-wired regulators may be mounted in either a horizontal or vertical position. If mounted in a vertical position (on a wall, for example), steel mounting hardware must be selected in accordance with the following table. The wiring compartment should be at the top. Regardless of position, the regulator should be located where contact with the hot surface of the transformer is unlikely. For proper ventilation, allow a minimum of 12 inches of clearance above the unit and a minimum of 6 inches of clearance on each side. Dimensional data are presented in Table 3 and Figures 3, 4, 5, and 6.

| Rated VA of Unit | Minimum Size of Steel Mounting Hardware |
|---|---|
| 30 to 120 | #10 Machine Screws |
| 250 | 1/4" Diameter Bolts |
| 500 to 1000 | 5/16" Diameter Bolts |
| 1500 to 10000 | 3/8" Diameter Bolts |
| 15000 | 1/2" Diameter Bolts |

Hard-wired regulators must be connected to a branch circuit in accordance with local and national electrical codes. Refer to Table 5 for correct fusing and wire gauge sizes. Use UL Class RK-1 Type Fuses only.

If operation from a 3-phase source is required, three hard-wired regulators may be wired in delta as shown in Figure 10. NOTE: Required branch circuit protection must be located in the primary of each transformer, not in the three-phase line. The outputs must supply three, independent, single-phase loads of the same voltage rating. Figures 10 (a) and 10 (b) illustrate proper load connection.

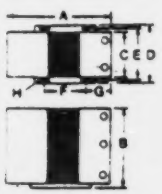



**Figure 3. Outline Drawing — 120 and 1000 VA Regulators**

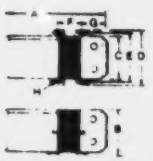
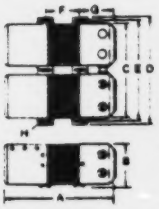
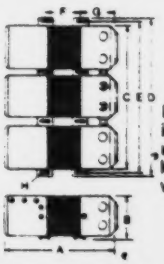



**Figure 4. Outline Drawing — 1500 thru 5000 VA Regulators**




**NOTE: Terminal Block is located in right unit. Use only the knockouts marked with X in Figure 5.**

**Figure 5. Outline Drawing — 7.5 and 10 kVA Regulators**




**NOTE: Terminal Block is located in center unit. Use only the knockouts marked with X in Figure 6.**

**Figure 6. Outline Drawing — 15 kVA Regulators**

## Table 3. Hard-Wired Micro/Minicomputer Regulators

| Voltage Ratings | | VA | Catalog Number | Outline Drawing | Wiring Diagram | Dimensions (Inches) | | | | | | | | Approx. Shipping Wt. (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Regulated Outputs (Vac) | Input Ranges (Vac) | | | | | A | B | C | D | E | F | G | H | |
| 120 | | 120 | 63-23-112-4 | Fig. 3 | Fig. 7 | 8.62 | 5.19 | 3.31 | 4.00 | 3.50 | 3.00 | 2.44 | .22 x .59 | 15 |
| | 95-130 | 250 | 63-23-125-4 | Fig. 3 | Fig. 7 | 9.88 | 7.44 | 4.50 | 5.38 | 4.75 | 4.12 | 2.19 | .31 x .69 | 27 |
| | 175-235 | 500 | 63-23-150-8 | Fig. 3 | Fig. 8 | 12.69 | 6.44 | 7.78 | 8.00 | 8.12 | 5.62 | 3.06 | .38 x .81 | 37 |
| | 190-260 | 750 | 63-23-175-8 | Fig. 3 | Fig. 8 | 13.69 | 6.44 | 7.78 | 9.00 | 8.12 | 5.62 | 3.06 | .38 x .81 | 52 |
| | 380-520 | 1000 | 63-23-210-8 | Fig. 3 | Fig. 8 | 16.75 | 6.44 | 7.78 | 9.00 | 8.12 | 5.62 | 5.25 | .38 x .81 | 62 |
| 120 | | 1500 | 63-23-215-8 | Fig. 4 | Fig. 8 | 16.44 | 9.03 | 10.56 | 12.75 | 11.75 | 3.00 | 5.19 | .44 x .69 | 95 |
| 208 | | 2000 | 63-23-220-8 | Fig. 4 | Fig. 8 | 17.31 | 9.03 | 10.56 | 12.75 | 11.75 | 3.88 | 5.19 | .44 x .69 | 109 |
| 240 | | 3000 | 63-23-230-8 | Fig. 4 | Fig. 8 | 18.69 | 9.03 | 10.56 | 12.75 | 11.75 | 5.25 | 5.19 | .44 x .69 | 142 |
| | | 5000 | 63-23-250-8 | Fig. 4 | Fig. 8 | 28.19 | 9.03 | 10.56 | 12.75 | 11.75 | 8.25 | 8.88 | .44 x .69 | 222 |
| | 175-235 | 7500 | 63-28-275-8 | Fig. 5 | Fig. 9 | 26.56 | 9.03 | 22.81 | 25.81 | 24.81 | 6.62 | 8.88 | .44 x .69 | 362 |
| | 190-260 | 10000 | 63-23-310-8 | Fig. 5 | Fig. 9 | 28.19 | 9.03 | 22.81 | 25.81 | 24.81 | 8.25 | 8.88 | .44 x .69 | 446 |
| | 380-520 | 15000 | 63-23-315-8 | Fig. 6 | Fig. 9 | 28.19 | 9.38 | 35.56 | 38.25 | 37.22 | 8.25 | 8.88 | .56 x .69 | 710 |

## Table 4. Connection Terminals for 3-ϕ Line

| Regulator VA | Line Voltage | Figure 10 Label | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F |
| 120 VA thru 5 kVA | 208 | H1 | H3 | H1 | H3 | H1 | H3 |
| | 240 | H1 | H4 | H1 | H4 | H1 | H4 |
| | 480 | H1 | H5 | H1 | H5 | H1 | H5 |
| 7.5 kVA thru 15 kVA | 208 | H2 | H3 | H2 | H3 | H2 | H3 |
| | 240 | H2 | H4 | H2 | H4 | H2 | H4 |
| | 480 | H1 | H4 | H1 | H4 | H1 | H4 |

## Table 5. Circuit Protection/Wire Gauge

| Sola Catalog Number | Input | | | Output | |
|---|---|---|---|---|---|
| | Rated Volts | Required Circuit Protection (A) | Minimum Gauge 90°C Wire | Rated Volts | Minimum Gauge 90°C Wire |
| 63-23-112-4 | 95-130 | 3 | 14 | 120 | 14 |
| | 175-235 | 3 | 14 | | |
| | 190-260 | 3 | 14 | | |
| | 380-520 | 1 | 14 | | |
| 63-23-125-4 | 95-130 | 6 | 14 | 120 | 14 |
| | 175-235 | 3 | 14 | | |
| | 190-260 | 3 | 14 | | |
| | 380-520 | 1 | 14 | | |
| 62-23-150-8 | 95-130 | 10 | 14 | 120 | 14 |
| | 175-235 | 6 | 14 | 208 | 14 |
| | 190-260 | 6 | 14 | 240 | 14 |
| | 380-520 | 3 | 14 | | |
| 63-23-175-8 | 95-130 | 15 | 14 | 120 | 14 |
| | 175-235 | 10 | 14 | 208 | 14 |
| | 190-260 | 6 | 14 | 240 | 14 |
| | 380-520 | 3 | 14 | | |
| 63-23-210-8 | 95-130 | 15 | 14 | 120 | 14 |
| | 175-235 | 10 | 14 | 208 | 14 |
| | 190-260 | 10 | 14 | 240 | 14 |
| | 380-520 | 6 | 14 | | |
| 63-23-215-8 | 95-130 | 25 | 10 | 120 | 12 |
| | 175-235 | 15 | 14 | 208 | 14 |
| | 190-260 | 15 | 14 | 240 | 14 |
| | 380-520 | 10 | 14 | | |
| 63-23-220-8 | 95-130 | 30 | 10 | 120 | 10 |
| | 175-235 | 20 | 12 | 208 | 14 |
| | 190-260 | 15 | 14 | 240 | 14 |
| | 380-520 | 10 | 14 | | |
| 63-23-230-8 | 95-130 | 45 | 8 | 120 | 8 |
| | 175-235 | 25 | 10 | 208 | 12 |
| | 190-260 | 25 | 10 | 240 | 12 |
| | 300-520 | 15 | 14 | | |
| 63-23-250-8 | 95-130 | 80 | 4 | 120 | 8 |
| | 175-235 | 40 | 8 | 208 | 10 |
| | 190-260 | 40 | 8 | 240 | 10 |
| | 380-520 | 20 | 12 | | |
| 63-28-275-8 | 175-235 | 60 | 6 | 120 | 4 |
| | 190-260 | 60 | 6 | 208 | 8 |
| | 380-520 | 30 | 10 | 240 | 8 |
| 63-28-310-8 | 175-235 | 80 | 3 | 120 | 3 |
| | 190-260 | 80 | 4 | 208 | 6 |
| | 380-520 | 40 | 8 | 240 | 8 |
| 63-28-315-8 | 175-235 | 125 | 1 | 120 | 0 |
| | 190-260 | 110 | 2 | 208 | 4 |
| | 380-520 | 60 | 4 | 240 | 4 |

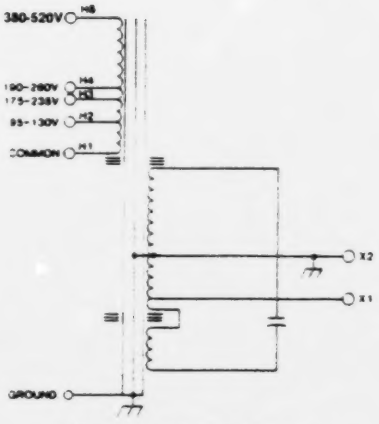
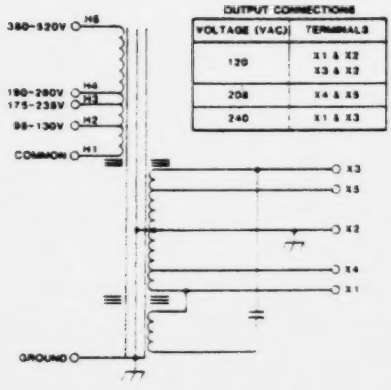


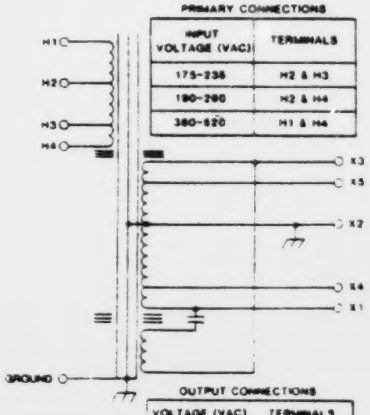

Figure 7. Wiring Diagram — 120 and 250 VA Regulators




OUTPUT CONNECTIONS

| VOLTAGE (VAC) | TERMINALS |
|---|---|
| 120 | X1 & X2<br>X3 & X2 |
| 208 | X4 & X5 |
| 240 | X1 & X3 |

Figure 8. Wiring Diagram — 500 thru 5000 VA Regulators



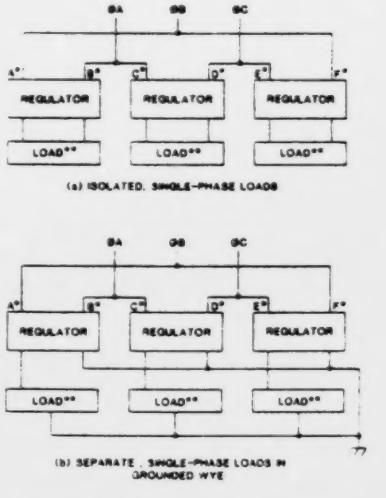

PRIMARY CONNECTIONS

| INPUT VOLTAGE (VAC) | TERMINALS |
|---|---|
| 175-238 | H2 & H3 |
| 190-260 | H2 & H4 |
| 380-520 | H1 & H4 |

OUTPUT CONNECTIONS

| VOLTAGE (VAC) | TERMINALS |
|---|---|
| 120 | X1 & X2<br>X3 & X2 |
| 208 | X4 & X5 |
| 240 | X1 & X3 |

Figure 9. Wiring Diagram — 7.5, 10, and 15 kVA Regulators




*CONNECT PER TABLE 4
**CONNECT PER FIG. 7 (120 & 250 VA), FIG. 8 (500 THRU 5000 VA) OR FIG. 9 (7500 THRU 15000 VA)

Figure 10. Three-Phase Power and Load Connections

# OPERATING NOTES AND DATA

### Safety Notice

High voltages are present inside the regulator. Do not reach inside the unit while it is energized. To measure voltage, de-energize the unit, connect the meter, and then re-energize the unit.

### Checking With Voltmeters

All input and output voltage measurements should be made with a true rms-responding voltmeter, such as a dynamometer or thermocouple type. A reasonably-close measurement can also be obtained with those iron-vane types which are rated for "25-500 Hertz" or broader frequency range. A certain amount of harmonics in the output may cause other types — particularly rectifier types — to give inaccurate indications.

### Ratings and Characteristics

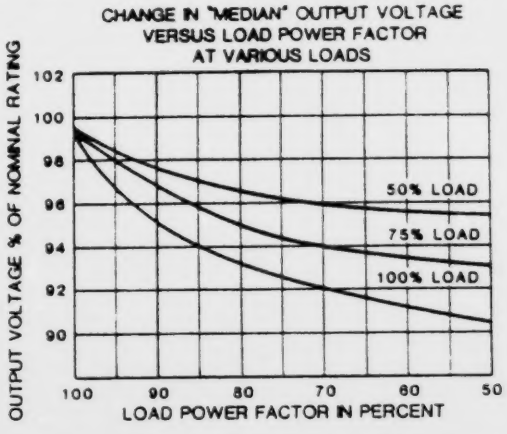
Micro/Minicomputer Regulators come in various input and output voltages, input and output VA ratings and frequencies. See name plate attached to each regulator for appropriate data.

### Load Regulation

Changes in output voltage resulting from changes in resistive loads from no load to full load (100% P.F.) are approximately four percent.

### Effect of Load Power Factor

"Median" value of output voltage will vary from nameplate rating if the load has a power factor other than that for which the transformer was designed. Load regulation will also be greater as the inductive load power factor is decreased (see adjacent chart of average values). However, the resulting



median values of output voltage will be regulated against supply line changes at any reasonable load or load power factor.

### Effect of Frequency

Changes in the frequency of the supply voltage will be directly reflected in the output voltage. A change of about 1.8% in output voltage will occur for every 1% change in input frequency, and in the same direction as the frequency change.

### Response Time

An important advantage of the Sola principle of static magnetic regulation is its exceedingly fast response time, compared with other types of AC regulators. Transient changes in supply voltage are usually corrected within 1-1/2 cycles or less; the output voltage will not fluctuate more than a few percent.

### Input Characteristics

The regulator transformer includes a resonant circuit which is energized whether it is serving load or not. Therefore, the input current at no load is approximately 35% of the full-load primary current. As a result, the temperature of the unit may rise to substantially full-load level, even at light or no load. Input power factor will average 90-100% at full load, but may drop to about 75% at half load and 25% at no load. In any case, it is always leading.

### Current Limitation

When the load is increased beyond the regulator's rated value, a point is reached where the output voltage suddenly collapses and will not regain its normal value until the load is partially released. Under short-circuit conditions, the load current is limited to approximately 150% of the rated full-load value, and the input power to less than 10% of normal. The Micro/Minicomputer Regulator will protect both itself and its load against damage from excessive fault currents. Fusing of load circuits is not necessary.

### Operation on Motor Loads

Because of the current-limiting effect described above, special attention should be given to motor applications. In general, the regulator must have a load rating nearly equal to the maximum power drawn during the starting cycle. This may run from two to eight times the normal (running) rating of the motor. In doubtful cases, it is advisable to measure the actual starting current.

### Multiple Operation

Two or more hard-wired models of the same rating may be connected with their input and output in parallel. However, on models smaller than 5KVA, do not parallel both 208V (X4-X5) and 240VCT (X1-X2-X3). This may damage the output windings.

### Operating Temperature

Standard units are designed to operate in ambient temperatures of minus 20 °C to plus 50 °C. In operation, a temperature rise will occur whether or not the transformer is serving load. Normally, this rise may fall anywhere in the range of 45 °C to 110 °C, depending on the regulator type and rating. In any case, the maximum operating temperature at an ambient of 50 °C is always within safe operating limits for the class of insulating material used.

### Effect of Temperature

The output voltage will show a small change as the unit warms up to stable operating temperatures at a constant ambient temperature. This change may be about one or two percent, depending on the unit's VA rating. At a stable operating temperature, the output voltage will change slightly with varying ambient temperature. This shift is approximately one percent for each 40 °C of temperature change.

## SERVICING

### No Routine Maintenance Necessary

Because the Sola Micro/Minicomputer Regulator is a simple, rugged device without moving parts or manual adjustments, no routine servicing or maintenance is needed. In case of apparent poor performance, the user is urged to check the following points immediately:

### Checklist on Factors Affecting Performance

**A. Nominal Voltage Too High**

1. The load may be considerably less than full rating. (See note on "Load Regulation".)
2. The load may have a leading power factor.

**B. Nominal Voltage Too Low**

1. Load power factor may be lagging.
2. Unit may be slightly overloaded. (See note on "Current Limitation".)

**C. Does Not Regulate Closely**

1. Unit may be slightly overloaded. (See note on "Current Limitation".)
2. Actual line voltage swings may be outside the rated range of unit, particularly on low side.
3. On varying loads, a certain amount of load regulation may be mixed with the line voltage regulating action. (See note on "Load Regulation".)

**D. Output Voltage Very Low (20-60V)**

1. Unsuspected or unplanned overloads of substantial size may occur intermittently (motor-starting currents, solenoid inrush currents, etc.). (See note on "Current Limitation".)
2. One or more capacitor units in the regulator may be defective.

**E. No Output Voltage**

1. Check power source breakers or fuses.
2. Check input switch (on portable units).
3. Check continuity between input terminals, and also between output terminals.

**F. Transformer Operating Temperature**

1. The transformer used in these regulators is designed to operate at high flux density, and hence, relatively high temperatures.

   After connection to line for a half hour or so, the transformer core structure may be too hot to touch with bare hand. This is normal and need give no concern.

**NOTE: In case regulator is operating but does not appear to have correct output, IT IS VERY HELPFUL TO APPLY THE FOLLOWING TEST:**

1. Disconnect the working load.
2. Connect a dummy load of lamps, heaters, or other resistive load substantially equal to the full-load rating of regulator, directly across its output terminals.
3. Measure the output voltage of the regulator using a true rms type voltmeter directly across its output terminals.

This test will usually establish whether the apparent poor performance is due to a fault in the regulator or to some peculiarity of the working load.

**Field Replacement of Capacitors**

Capacitors used in all regulators are the highest commercial grade. Each one is given a rigid acceptance test upon receipt. Nevertheless, as with all capacitors, there is a certain small percentage of failure. The Sola guarantee includes free replacement at the factory of any capacitor unit which fails within one year of sale. Older units can be replaced at moderate charge.

Where competent technical help is available, it may be possible to test and identify defective capacitors in the field, and to make field replacement with new capacitors shipped from the factory. In all such cases, factory advice and cooperation must be requested in advance.

**Guarantee**

Sola Micro/Minicomputer Regulators are guaranteed against failure due to faulty materials or workmanship for a period of one year from date of sale. See instructions about adjustments in preceding pages.

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